Power and The Engineer

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ADVERTISING is one of the biggest piers in the foundation upon which business success is built.

If you wish to make sure of this fact, glance through the Selling Section of this issue. The big "folk" are there,—concerns which one would think did not need any more publicity than they already have.

Manufacturers advertise for one reason,—*it pays*—else why should manufacturers who are widely and favorably known spend their money for space in the various magazines?

Another way in which successful manufacturers advertise is by putting quality into the goods which they send out. Their products are *as represented.*

Satisfied purchasers make mighty fine "boosters."

In a business way, then, two methods of advertising go hand in hand, to wit: *representation* and *materialization.* And without the other, the first of these is of small avail.

An engineer's stock in trade is his ability. Every engineer owes it to himself to advertise.

Now, it would not do an engineer any good to charter the front page of POWER in order to tell ten thousand power-plant managers what a "*crack-a-jack*" he is, for he can be of use in only one plant at a time.

Then advertising by *representation* is not of much benefit.

But advertising by *materialization—making good*—is without doubt the best of the ways to success.

Stopping leaks, making repairs promptly and neatly, keeping things clean and in smooth-running order; in other words, keeping the plant in the "pink of condition"—doing his best without being urged—these are among the things that advertise an engineer.

Results count, and an engineer that does his work on this basis will win out in the end.

Ordinarily, when a man is in the market for, say, a boiler, he first decides upon the kind of boiler he wants and then finds out who manufacture boilers which conform to his requirements.

He finds this out by studying the design and material of the boilers that have been brought to his attention.

When a man needs the services of an engineer, he judges the ability of the candidates more by what they have *done*—their records—than by what they *say* they can do or by what it is *alleged* that they can do.

If you know how the efficiency of the plant can be increased, the way in which to benefit by the knowledge is to use it, not merely to tell about it.

If your employer does not show appreciation of what you do, somebody, sometime, somewhere, will.

Making use of your ability does not decrease it, but, on the contrary, adds to it.

Keep busy!

First Oil Burning Turbine Steamers

By Warren O. Rogers

A change from coal to oil fuel reduced the steaming time from port to port and cut down the number of boiler attendants from 48 to 12. From tanks below the boilers oil is pumped at 131 pounds pressure to the burners, where it is atomized by means of superheated steam.

The steamships "Yale" and "Harvard," of the Metropolitan line, running between New York and Boston, were the pioneers in the adoption of the steam turbine on the Atlantic coast, and again are the first steam-turbine vessels to use oil as fuel. The Lassoe fuel oil-burning system has just been installed by the W. & A. Fletcher Company, Hoboken, N. J., from designs and under the supervision of Robert McGregor, consulting engineer of the Metropolitan Steamship Company.

While there will not be any marked economy of oil fuel over coal, there are some excellent advantages. For instance, the steaming time between the two ports will become a fixed factor, the ships will be cleaner, due to the absence of coal dust when replenishing the coal bunkers, and soot from the stacks when under way. The expense for labor will also be reduced, owing to the reduction from 48 to 12 boiler attendants. In all probability the life of the boilers will be lengthened, as there will be no necessity for cleaning fires and exposing the hot plates to cold drafts of air. Also, a more even steam pressure can be maintained, which will tend to prevent a loss in speed.

Fig. 1 shows a general view of the aft boiler room of the steamer "Harvard," in which are six 1000-horsepower marine type of boilers, each having three furnaces. The oil is stored in four oil tanks located under the forward and aft boiler-room floors. These tanks have a capacity of 100,000 gallons of crude oil, which give the vessel a steaming radius of 650 miles. To prevent the oil from escaping, coffer dams are fitted to each end of the fuel-oil section. These being full of water under pressure prevent the escape of the oil to any other part of the ship.

The fuel oil is pumped from the oil barges and delivered to the furnaces as follows: A 6-inch hose connection is made from the oil barge to an intake pipe on the main deck of the ship, from which the oil is conducted through pipes directly into the double bottom. From the double bottom the oil is pumped by a 9 and 5 by 10-inch Warren duplex suction pump into two large settling tanks, having a total capacity of 6000 gallons. This quantity is sufficient to steam the vessel about four hours at full speed. From the settling tank the oil is drawn by a 9 and 5 by 10-inch Warren duplex force pump, and, after passing through two series of filters and an oil meter, is conducted along the main 3-inch supply pipe, branching out to the individual burners. Each steamer has 36 burners, or three under each boiler.

The oil is discharged into each settling tank at the top and the suction-pipe connection is made 3 feet from the bottom. While oil is settling in one, the supply for the burners is taken from the other. Both settling tanks are connected by a pipe running into the bottom of each, so that the supply can be equalized if desired. One pump is used for filling, although there are two force pumps, either one of which may be utilized for filling the tanks. There is also a 5 and 3½ by 5-inch Warren duplex steam pump which is used as an auxiliary force pump for feeding oil to the few burners used when the steamer is coming into port. The feed pumps work on 100 pounds steam pressure and force the oil to the burners at a pressure of 131 pounds per square inch.

The suction pipe of the pump supplying oil to the settling tank is connected to a manifold located between the two force pumps. To this manifold are connected the four oil pipes running to the fore and aft starboard and port oil tanks which are separated by a centerboard. To this manifold is also connected the filling pipe through which the four tanks receive their supply of oil from the oil barges lying alongside the steamer. Each tank has a separate filling pipe branching from

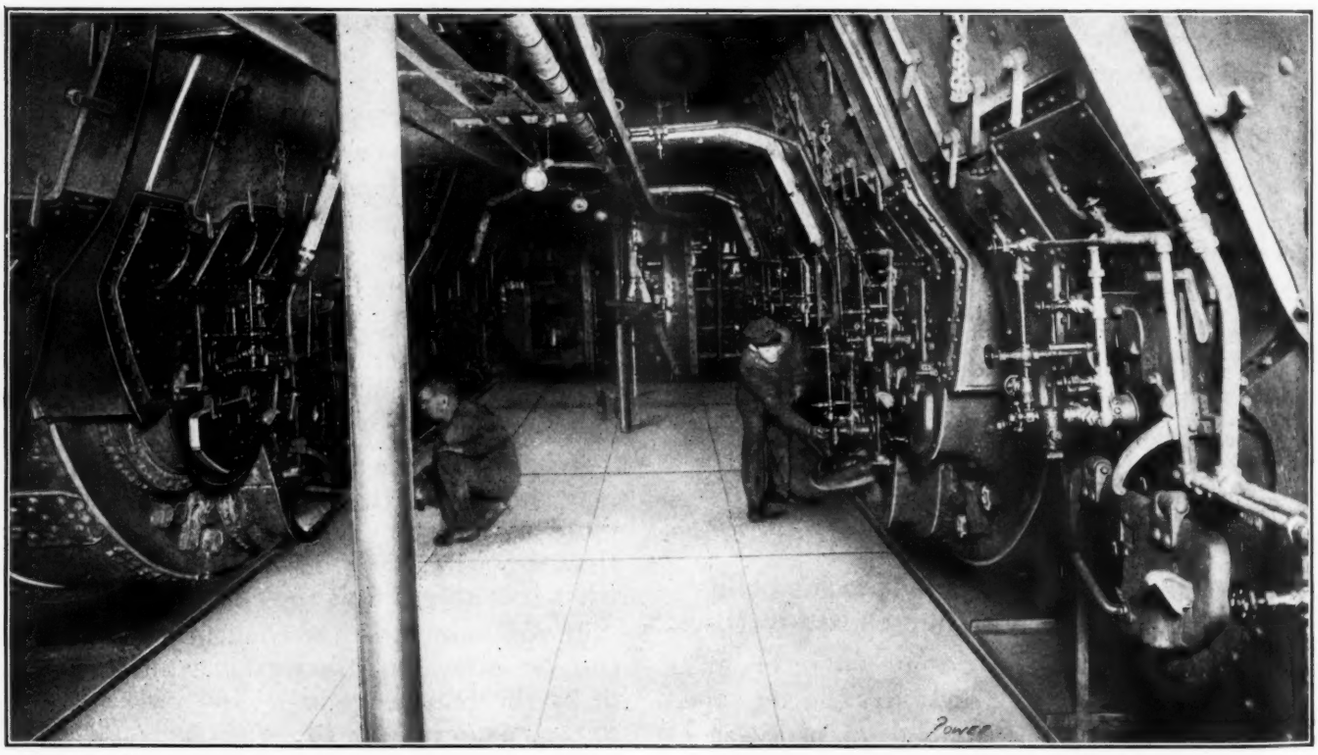


FIG. 1. AFT BOILER ROOM OF THE STEAMER "HARVARD"

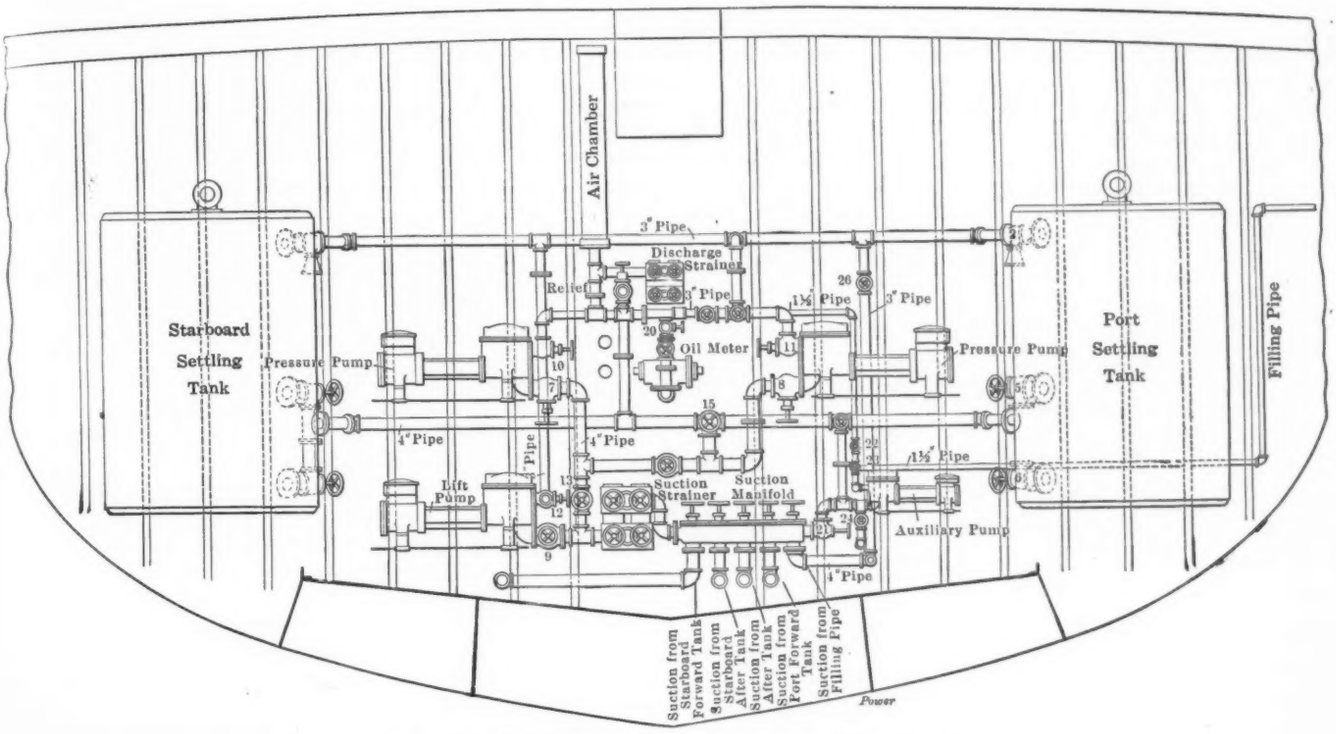


FIG. 2. GENERAL ARRANGEMENT OF OIL PIPING SYSTEM

the main pipe, each fitted with a stop valve.

As the oil is pumped from the tank to the settling chamber it is passed through a double strainer, one side of which can be cleaned while the other is in operation. The oil is strained a second time when it is pumped from the settling tank to the burners. Fig. 2 shows the general arrangement of the pump, settling tank and piping, which are located on the bulkhead forming the partition between the aft boiler and turbine rooms.

Each oil tank is provided with a steam pipe so that in case of fire steam can be turned on to smother it.

Another precaution is the arrangement of a valve in the main oil pipe running to the boiler. This valve has an extension valve stem running to the main deck of the steamer, so that in case of accident

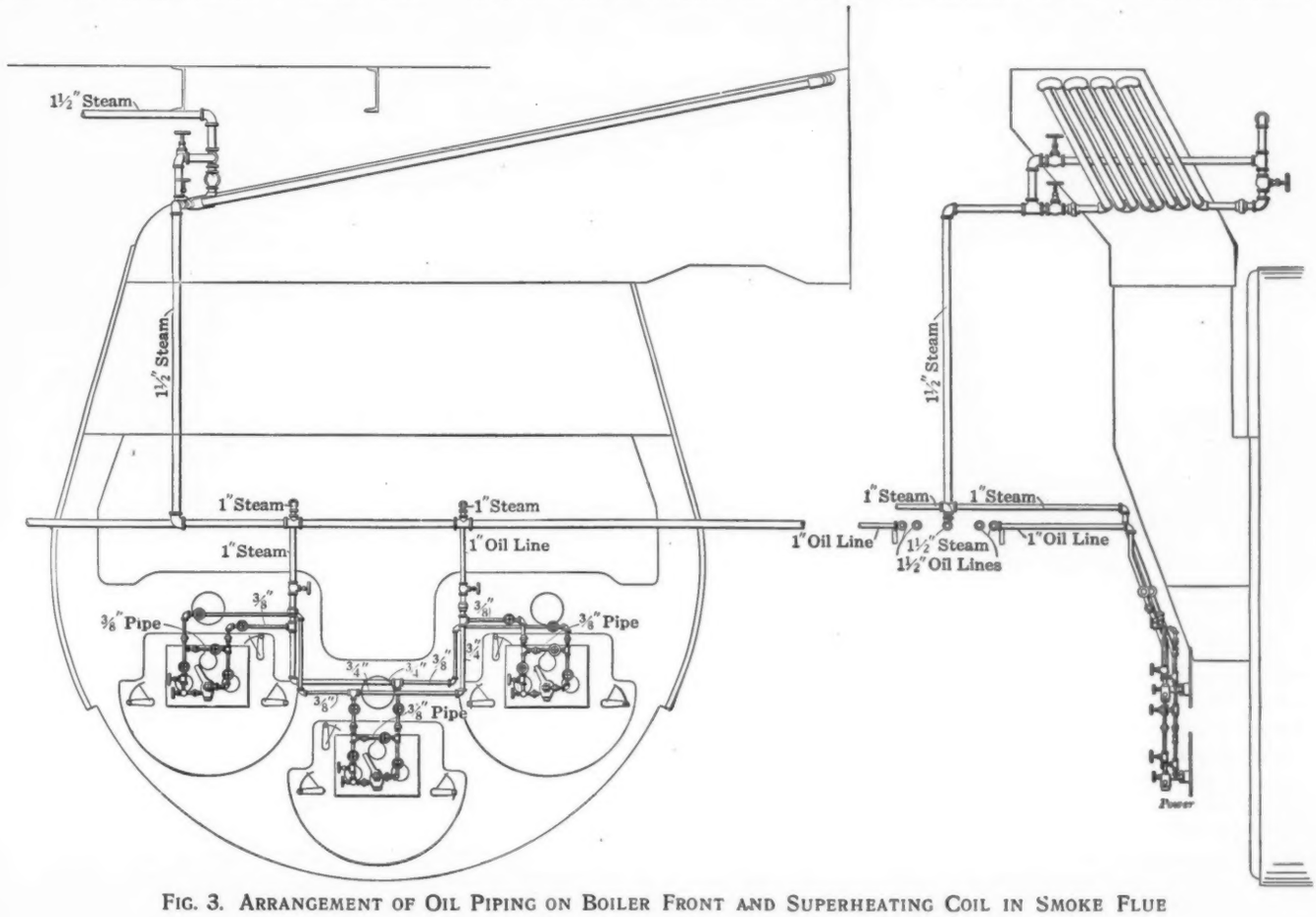


FIG. 3. ARRANGEMENT OF OIL PIPING ON BOILER FRONT AND SUPERHEATING COIL IN SMOKE FLUE

in the boiler room the entire fuel supply can be shut off without entering the stokehole. Each oil tank has a telltale gage and the settling tanks are both fitted with a gage glass at the bottom and three trycocks at the top. The oil tanks are also equipped with vent pipes so that gas may escape outside of the boiler room.

ing through the coil the oil is delivered to the mixing chamber of the burner. The atomized oil and steam are then discharged to the furnace through the burners. Figs. 1, 3 and 4 show the arrangement of the piping and the mixing chamber of the burner on the front of the furnace. The steam and oil are regulated by separate valves. The burner is shown in detail

firemen look. Too much oil will produce smoke, so the amount of oil fed can be gaged accordingly. Bypass pipes admit of cutting out the oil-heating coils in case they become burned out, and the burners can then be kept in operation until the ship reaches port. A forced draft of 1.2 inches is used.

When a steamer arrives in port the oil

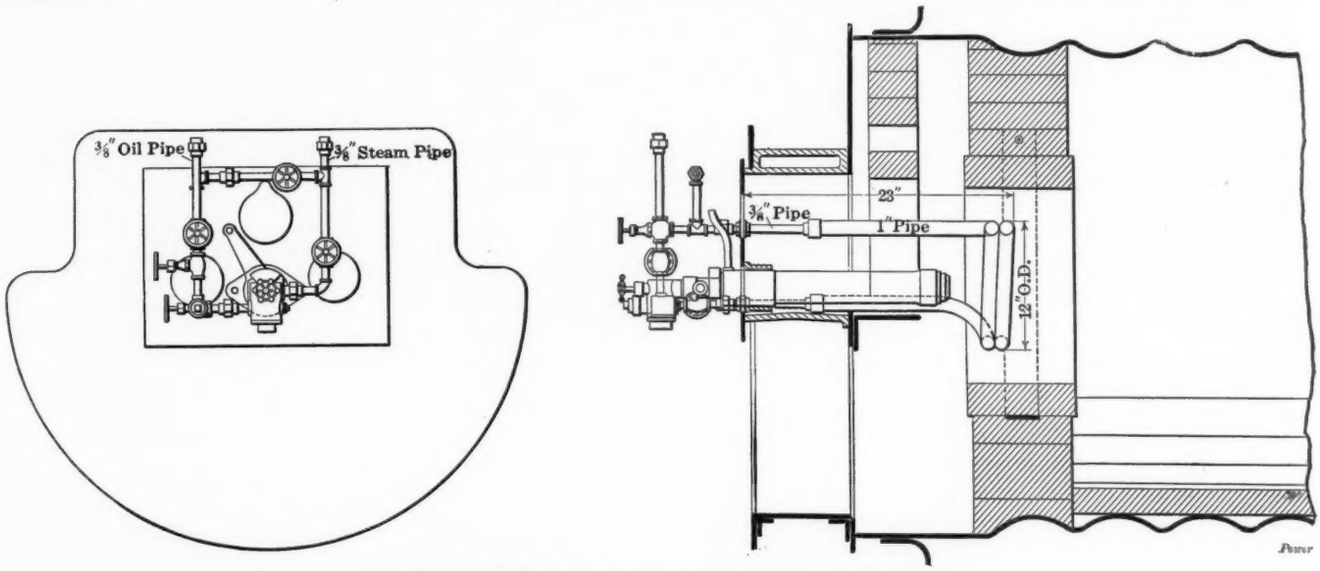


FIG. 4. METHOD OF INSTALLING OIL BURNER IN FURNACE

Each furnace is fitted with a Lassoe oil burner, and the bottom of each furnace is lined with suitable firebricks which extend half way up the side. The oil is atomized by means of superheated steam. The superheating coils are placed

in Fig. 5. Steam enters at *A*, oil at *B*. The threads on the stem of the oil valve are made close to the valve so that the expansion of the valve stem will not affect the valve opening, as would be the case were the thread placed next to the

burners are shut off and cleaned and the furnace cleared of gas by opening the lower door and the damper in the stack. Steam is then turned on until the gas has been blown out of the furnace. The burners are lighted by means of a suit-

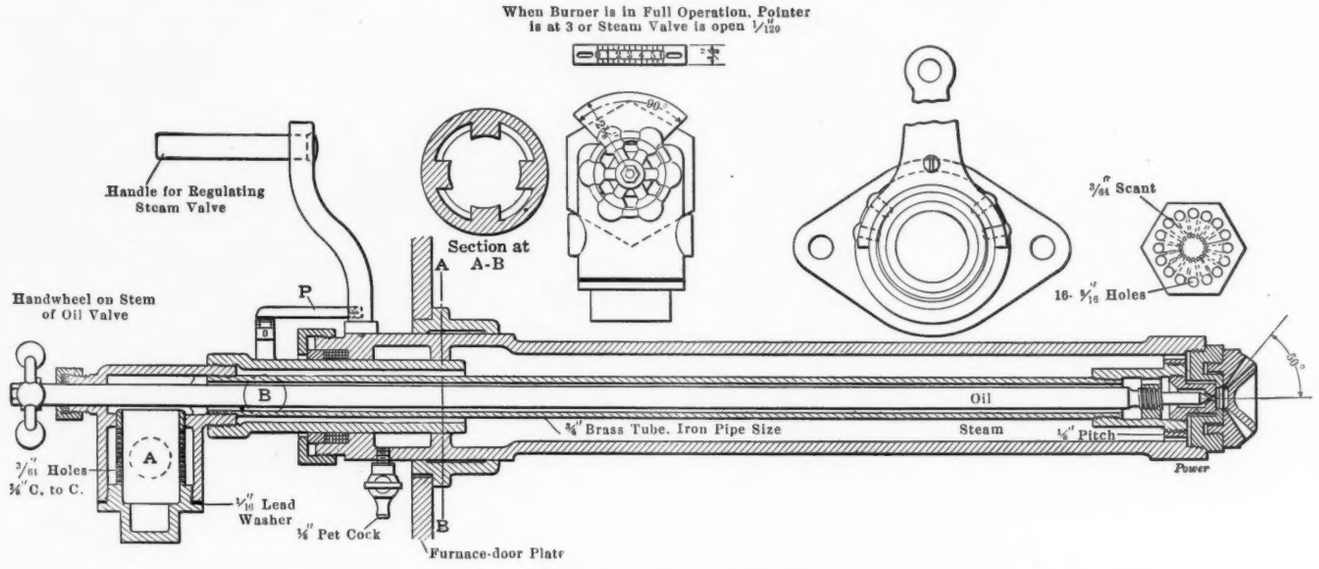


FIG. 5. SECTIONAL VIEW OF OIL BURNER

in the smoke flue of each boiler, as shown in Fig. 3. The steam is brought down, after passing through the coils, to the front of the boiler furnace and admitted to the mixing chamber or atomizer of the burner. The oil is heated by passing it through a coil of 1-inch pipe which extends into the brick-lined mouth of the furnace, as shown in Fig. 4. After pass-

handwheel. A scale at the steam-valve handle indicates the amount of steam-valve opening. When the burner is in full operation the pointer *P* is at figure 3 on the scale and the steam valve is open 1/129 inch. The oil sprays from the burner at an angle of 50 degrees.

The conditions of the fire are determined by peekholes through which the

able torch attached to an iron rod about 4 feet long.

The four oil pipes supplying the burners with oil extend overhead the entire length of the two boiler rooms, while the pipe supplying steam to the superheaters is placed between them. At the present writing comparative cost figures on oil and coal burning are not available.

Museum of Watt Developments

By I. W. Chubb

At the sale of the firm of Boulton & Watt, some fifteen years ago, a valuable collection of relics of James Watt, Matthew Boulton and eminent men connected with them were purchased by George Tangye and placed in a special room belonging to the firm of Tangyes, Ltd., of Birmingham. This article is devoted to some of the famous drawings, letters and other relics contained in the Tangye museum.

When fifteen years or so ago the firm of Boulton & Watt, Soho, near Birmingham, England, was sold, there was danger that many of the relics of James Watt, Matthew Boulton and the eminent men connected with and following them might be dispersed or destroyed. They had been collected for a number of years from old drawers and other out of the way places by the late W. H. Darlington, who was for twenty years or more manager of the concern, assisted by his son, Seymour N. Darlington, for ten years or so. As a small matter of mechanical-engineering history it may be mentioned that the trustees, recognizing that the collection was due to the initiative of the elder Mr. Darlington, left the disposal of the room practically in his hands. In the nick of time the museum contents were sold for £500 to George Tangye, of the well known Birmingham firm. The large number of documents and other things have now once again been stored with care in a special room which is part of the building in which the firm of Tangyes, Ltd., manufacture their machine tools. It is on the opposite side of the road from the main Cornwall works which are devoted to engines, pumps, etc. It is understood that eventually the contents will be given to the City of Birmingham.

A few appliances are included and a number of old pamphlets on engineering affairs, but for the most part the relics take the form of letters and drawings, and while both are of technical interest and value, the letters constitute a set of documents invaluable to the student not only of early engineering, but also of the character of Watt, his associates and successors. Three views of the Tangye Watt museum are given in Figs. 1 to 3, the first two being side views, left- and right-hand respectively, while the other shows the end, with the door that is so strictly guarded. Down one side will be seen busts respectively of W. Murdock, Watt, G. Stephenson, R. Stephenson, Sir William Fairbairn, James Penn, with Watt and Murdock again at the end. Most of the letters are docketed and stored in drawers with sliding panels to keep out dust. The drawings are treated in much the same way and kept in portfolios, except that in some cases they are fixed in wall cases. The books, too, are numbered and arranged as shown in Figs. 2 and 3, and in the cupboards. It is, perhaps, not quite true that all these documents have been examined and indexed. This will be understood when it is stated that, including reverse copies, the drawings above are estimated to number between 36,000 and 40,000.

Drawings

The drawings range over practically the whole of at least the earlier activities of the Boulton & Watt firm, being mostly confined, however, to the end of the eighteenth century. The first one handled by the writer, for instance, shows a plan of an engine and boiler for Coalbrookdale, dated June, 1781—Coalbrookdale where Newcomen pumping engines had for some years previous been manufactured. In most cases the draftsmanship is certainly more patient than is allowable under present competitive conditions. The drawings are nearly all in a remarkable state of preservation, with lines and colors apparently as distinct in many instances as when the drawings were first made. This, of course, is not always the case. The next drawing handled, dated 1778, had the paper fretting away. The drawing shows the Bow engine, 1775, with Watt's own handwriting, the engine of which the completion was urged by Boulton in order for one thing to disprove the assertion of the London Society of Engineers that the necessary tools and skill were not available for its manufacture. Another drawing shows a pump designed by Smeaton and made by Boulton & Watt, the drawing being entitled "Elevation of the great Engine for the fifth arch of London bridge, March, 1787." Smeaton, it will be recalled, designed the pump to be worked by the rise and fall of the tide for the City of London water supply. In many cases the drawings have been mounted. A legend on the back of one of the drawings "Working gear for Soho, 1795," is not altogether unfamiliar, namely, "This drawing is the property of Boulton & Watt, who beg that it may be kept clean, not permitted to be copied, and returned to them as soon as the engine is finished."

A pencil drawing by one of the younger Hornblowers apparently given to W. Murdock, may be handled. A parallel motion for a rolling-mill engine is shown under date, 1792, and a windmill used in Holland in 1800. Plans of the Soho mint, 1788, can also be seen, and others, made about 1799, for the equipment of a mint in Russia. From the Soho mint Boulton supplied the British copper coinage from 1797 for about 10 years, and

Fig. 1. Left-hand Side of Watt Museum

at one time or another was connected with the mints of India, Russia, Spain, Denmark and Mexico.

Description of Robert Fulton's Steamboat

A portfolio of drawings can also be seen with a description of the steamboat

Fig. 2. Right-hand Side of Watt Museum

invention of Robert Fulton, dated January 1, 1809. It is uncertain whether all the drawings were by Fulton himself, though this is thought to be the case, and Andrew Carnegie, in his book on Watt in the Famous Scots Series, has stated that Fulton ordered an engine from his own drawings on August 6, 1803, and repeated the order personally in 1804. Anyway, the stern wheel, paddle and floating stage are shown, the drawings being signed by R. Fulton, August 6, 1803, and July 8, 1804, and the firm made the engine according to these drawings. America received it in 1805 and two years later it was placed in the "Clermont" on the Hudson river.

Letters

It is possible, however, that the letters to be seen are of even greater interest. In the first letter book of the firm, dated 1775, a letter by Watt is included addressed to Sir Harbord Harbord, August 4, suggesting that "If good elm or other wooden pipes can be procured that will stand 60-foot head of water at 3-inch bore, the pipes from the engine to the office may be of that material." Resting at the side is a section of elm received by Tangyes under date April 21, 1902, from the East London Waterworks Company (now absorbed in the Metropolitan Water Board), whose engineer says: "I have sent by London & Northwestern Railway a piece of an elm pipe taken up in the East End of London. These pipes were put down to enable the 'fire engine' made by Messrs. Boulton & Watt, somewhere about the year 1770, to pump into the district. A great many miles of other wooden pipes were also used by the company, the motive power being the water wheels and tidal wheels at Stratford."

Commercial men in engineering firms may be interested to read one of the letters sent out by Boulton & Watt, dated Soho, 15 Jan., 1870, as a request for payment:

Messrs. ———

Being in want of money at this time, have taken the liberty of sending your account for engine materials, as above amounted to 72-4-¾. Your sending us a remittance for the amount will oblige,

(*Signed*) J. Pearson.

The said J. Pearson appears at that time to have been an office boy. A little later, when letters were copied in the press, he had become an accountant.

Letter to Abbé de Calonne

Another interesting document shown to the writer was a letter written by Watt on behalf of the firm to the Abbé de Calonne. R. H. Kirton has suggested that he was the brother of C. A. de Calonne, the controller general of France, the man who, according to the books, by his financial methods did more than most people to precipitate the French Revolution. However, in 1786 he concluded a commercial treaty with England which led greatly to the increase of French imports into Britain. Moreover, after his dismissal in April, 1787, he fled to England. The letter was not written direct to the minister owing to Watt's inability to express himself in French. It is dated Birmingham, February 10, 1787, some two months before the fall of de Calonne. Watt, it will be remembered, had been to France in 1786 to consult with the existing government regarding the receipt of the firm's machinery; in fact, Boulton & Watt brought back P. Droz and his split collar for coining, subsequently abandoned. To return, the letter is 11 pages long and cannot be quoted at full length. In it, toward the end, however, Watt enunciates some

Fig. 3. End View of Room

truths regarding national jealousies and fiscal matters which, even in our own days, seem to become obscured or forgotten.

Letter of James Watt to Abbé de Calonne on behalf of Boulton & Watt

Feb. 10, 1787.

"Everybody of observation here speaks with admiration and applause of the regulations which Mr. le Controleur-General means to propose to the assembly of the notables, and express a wish that our ministry would follow the same great line in simplifying our taxes. . . . . but that part of our patriots who are not over liberal fear that he will by freeing your commerce and agriculture from its shackles, make France too rich and too great for the welfare of Britain and its trade. We argue otherwise for we say that if these measures contribute to increase your manufactures or commerce, that our government will be *obliged* to lay aside the erroneous part of their system, and free our manufacturers from their grievances, and that the richer France becomes, the better customer she can be to Britain, and that at the worst, if no change of system is adopted here and our trade becomes ruined by the agrandisement of yours, that you will have made France so desirable a country that all active men who are not rooted to the soil like so many vegetables, will remove thither and help to make it still greater, leaving our tyrannical landholders to pay the national debt, to eat their own corn, and muddle their own understanding with their own ale, without one enlivening drop of burgundy except what the wool of their sheep can purchase. We hope, however, that both nations will be wise enough to profit by each others' good examples and to pursue them without each others' follies, and that both will have reason to rejoice in the benefits of the commerce produced by the present treaty, which so many at present oppose in this country.

"Mons. de'Calonne did us the honour to say at our last [Memo. Two lines missing here. Conjectured that matter runs 'over last interview . . . . If their'] minister is so too; there will be perpetual peace between 'France and England, and no nation in Europe will dare to go to war with another.' We repeated these words to Mr. Pitt, to which he answered 'that would be a most desirable and most glorious thing *if* such are their real sentiments.' You see, they both rest on the *'if.'* In my opinion they were both sincere, but which of them can answer for a change of sentiment from future contingencies, or for the actions of their successors? In the meantime they are in the right road, and I believe both nations most sincerely join them in praying for the said perpetual peace; but our countrymen fear yours are not sincere, and probably yours have the same fears; a continuance of peace and social intercourse will in the end remove these jealousies. In the meantime, let us use our endeavors within the small circle we revolve in to rub off some of the asperities.

"I send you a small treatise on the subject of taxation which I composed about two months ago, in a fit of rage at the imposition of several new taxes on manufactures; but which I have reason to believe was productive of no good effects, so infatuated is our government in using their endeavour to kill the hen which lays the golden eggs, and so tenaceous are our landed gentlemen *of what they call property,* reckoning us poor mechanics no better than the slaves who cultivate their vineyards; fortunately, however, they live in a country and age . . . . [missing] live without you, but you cannot have your luxuries without our help.

"When I look back on the state of intoxication in which we were kept at Paris by the very flattering civilities and attentions and unmerited praises we received and the good wine we drank, I fear we were guilty of many rudenesses and incivilities, and said and did many improper things. If, therefore, you feel we have done so in your presence, or towards you, we entreat you to forgive us, to believe they proceeded from no want of regard or respect to those who honoured us with their company, and to make our excuse to any we may have offended."

Watt apparently is never afraid to write, or to mention, his dyspeptic headaches. On the other hand, letters in the collection show that John Rennie seldom wrote long letters. He was employed by the Soho firm and worked at the grinding details of the Albion flour mills, Southwark, where the firm put in the first parallel-motion, sun and planet engine in London, in 1786. Letters from the hand of Thomas Telford are also all short. The handwriting of the "princely Boulton" is notable on the surface for straightness of writing. Smeaton, who years earlier, was critical of the Watt engines, addresses Watt as "my dear friend," under date, 1784. Other letters are from Professor Black, Priestly, 1784; Josiah Wedgwood (associated with Boulton in opposition to proposed taxes on iron, copper, etc.), and "your humble servant" Lord Dartmouth (who offered to show the firm's copying presses to George III); while under date Goodwood, October 10, 1784, referring to these appliances, the Duke of Richmond writes, after the manner of the advertisement testimonial, "I find your copying press so very useful that I must desire you to send me another of them with all the apparatus compleat. This to be with iron rollers of the small or common size, etc."

An Example of Watt's Style

As a sample of Watt's style we attach a letter dated Bedworth, February 28, 1777. Old Jonathan is apparently Jonathan Hornblower, son of Joseph Hornblower, and Doctor Dodd is William Dodd, clergyman and author, who, forging a bond for £4200, was hanged as punishment in 1777.

"Bedworth, February 28th, 1777.

"Dear sir:—

"It is now clearly determined that Behemoth neither has nor shall stir his tail in the month of February, 1777. Some engineers talk of putting in steam to try the joints tomorrow. If they do they must be busy. If they wait till the Lord's day and have his assistance I don't know what they may do, but you need not think of coming, bringing nor sending anybody here until I bid you, otherwise you will only see a standing engine.

"Old Jonathan is to make their engine to use only seven tons of coals per 24 hours, if so our own gains will be moderate. Your late attorney here, Mr. D—y has, it seems, been much worse than Doctor Dodd. Many bonds of his fabrication, names and all have appeared, and yet the rogue was worth nothing, so much for high living. It will be necessary instantly to provide good piston rod iron, we immediately want several small ones. What appears to me best is immediately to write to Cleobury forge to draw some of their very best tough into eight square bars of the following sizes: 2 bars 6 feet long each 2½ diameter, for Chacewater; 4 bars 6 feet long each 2 diameter, Shadwell & Soho; 4 bars 6 feet long each 1¾ diameter; 8 bars 6 feet long each 1½ square or eight square, for sundries.

"Let the iron be got with all expedition, and I shall so soon as I come gloriously home contrive the means of manufacture.

"If now possible for you to, bring the ladies with you as the ground has got dry, if it keeps so, and I shall try to get an 18-oared barge laid at Longford against the day of the fiery trial. On consideration I still think that we should erect young Chacewater for surely the owners will not be such fools as to throw away a new engine which has cost them £1000, and if they should, if they use the engine a twelve month we should get near £300 by it. I think comparing it with York buildings second engine which is nearly of the same power and uses 4 or 5 bushels per hour—I believe the latter quantity—that we should get 1s. per going hour or thereabouts. It is impossible for me to do anything in the drawing way here for setting aside that I have no place but the parlor where the ladies always are—I come home commonly after 4 or 5 o'clock without my dinner, which I then eat heartily and immediately after get heavy legs which you know to be a certain consequence of cramming oneself yet who can resist when hungry, and good meat and drink in the way. I expect to hear from you tomorrow before I send this off."

Other Documents

Scores of indentures, certificates and articles of agreement dated from 1779 and onward are to be seen, together with prospectuses, patents, one or more with seals in tin cases, old Acts of Parliament, portraits of old engineers, dies and seals used by Boulton, Watt and Rennie, coins, a case containing drawing appliances, rules, memoranda and so on. For instance, there is a memorandum of agreement between James Constant Perrier and Boulton & Watt for the Paris Waterworks, February 12, 1779. Two years or so before this, according to the story, attempts had been made to get Watt's workmen over to France to divulge the engine secret. Letters from Gregory Watt, the son, may be seen; also an indenture between J. Watt, as mathematical instrument maker to the University of Glasgow, and John McLean, journeyman turner to Watt, dated Glasgow, July 14, 1761, in which McLean binds himself to Watt, being discharged in 1766. Documents give calculations respecting the saving of coal in Cornwall by the new Watt engine. In one case, for instance, the old engine consumed in two years 3100 tons at 10s., costing £1550. The new engine took 2039 tons at 10s., costing £1019 10s., which together with a premium for the use of the engine amounting to £303 19s., bill from Soho for £42, and tallow and hemp for two years at £60, totaled £1425 9s. and does not leave a very wide margin of profit for the mine owners, who paid for the engine also. It will be noted that in this case at least the premium was not at the usual rate of one-third the saving in coal consumed.

Another paper relates to the salary of the indispensable Murdock. In 1780, getting 20s. a week, he unsuccessfully applied for a "rise" to 42s. In 1810, however, his salary is £300, with a commission amounting to £317 10s., while for his gas-lighting apparatus he received £66 10s. or a total of £684. Concerning his gas inventions, it is reported that Murdock was at one time invited out to dinner in Manchester with Sir William Fairbairn. The two being fog-bound, Murdock surprised his companion by stopping and apparently lighting himself to show the way. Unknown he was carrying a bag of gas. Murdock's own house now stands, but in bad condition. Also Watt's indicator book with diagrams dating back to 1803 is to be seen, the diagrams being out of order of date, however. The well known diary of the weather from the years 1805 to 1818 may be just mentioned. The barometer was taken at 8 in the morning, at 2 in the afternoon and at 8 in the evening. Temperatures were also recorded, and directions of wind and statements of the general condition of the weather were added, together with any natural-history records—such as hearing the cuckoo, with a sketch of the bird itself.

A further note will suggest that human nature does not change greatly, for in the petty cash book of 1795 an entry is made relating to 2s. for beer allowed to men loading bricks. Among miscellaneous items may be added, reference to wages books of 1826 and onward, and balanced housekeeping accounts of James Watt, Junior, at Aston Hall on the other side of Birmingham.

Bare mention may be made of the patent sounding machine or log, invented by E. Massey, and the leather basket, also to be seen in Fig. 2, used by James Watt for bringing his lunch from Heathfield. Again there is the three-cornered leather-cushioned arm-chair, Watt's office chair, in which royalties have seized the opportunity to sit. Guns for the corps of volunteers raised in Soho, 1798, are also an exhibit.

Pamphlet of Jonathan Hull

Another interesting object is an engraving with letter press of Jonathan Hull's invention, with letters patent 1737. His pamphlet, "A description and draught of a newly invented machine for carrying vessels or ships out of or into any harbor, port or river against wind or tide in a calm" contains the following: "There is one great hardship lies too commonly upon those, who propose to advise some new, though useful scheme for the public benefit. The world abounding more in rash censure, than in the candid and unprejudiced estimate of things, if a person does not answer their expectations in every point, instead of friendly treatment for his good intentions, he too often meets with ridicule and contempt.

"But I hope this will not be my case but that they will form a judgment of my present undertaking only from trial.

"If it should be said that I have filled this Tract with things that are foreign to the matter proposed, I answer that there is nothing in it but what is necessary to be understood by those that desire to know the nature of that which I now offer to the world. And I hope that through the blessing of God it may prove serviceable to my country."

Watt's Copying Press

In a paragraph we may deal with Watt's copying press. This he invented in 1778 and, keeping it secret for two years, obtained a patent in 1780. The opposition of bankers, who were afraid of forgery, the demonstrations by Boulton to the members of the Houses of Lords and Commons, and other incidents concerned with this invention will be found detailed in the pages of Smiles. The invention was eventually a great success both in England and on the continent; in fact, somewhat later, special instructions were got out in French, a pamphlet being published in 1807 entitled "Maniere de se Servir de la Machine à Copier inventée et patentée par Jacques Watt & Co." The collection includes the press which was used at the works; see Fig. 1. It will be recalled that in the first instance the letters were copied on single sheets which were pasted into a book. This machine was attached to the table and pressure was obtained from rollers, which were preferred to screws by Watt himself. Watt devised a portable copying press fixed in a box which is clamped to the table. According to the description then given by the firm of the contents, "The box opens in the middle, and presents the copying apparatus on one side, a secretary for containing papers, letters, pens, etc., on the other. The copying apparatus consists of the press, with its two metallic rolls, which are put in motion by a handle or lever fitting upon the extremity of the axis of the upper roll, and of the double pasteboard to be introduced between the rolls, answering the uses of the board in the larger machines, and covered with Fearnought cloth for the purpose of elastic compression. A quarto sheet of writing paper folded up with copying paper and oiled paper interleaved, is placed between the pasteboards, to show the mode of copying four pages at a time. This being merely inclosed for the purpose of instruction, must be removed when you use the machine. The mode of copying one, two, or three pages, will be hence apparent, as you will only have to lay on fewer sheets of copying paper." It also contains a damping box, a measure for the quantity of water necessary for a given number of sheets, a wetting book, damping brush, drying book and the cramp. The secretary, in the upper part of the box, contained spare copying paper, writing paper and sponge papers "serving to smooth and dry the original from which you have taken a copy, by interleaving it with them, and repassing it through the press."

Henry Wright, of Small Heath, about eleven years ago stated that Watt applied his letter-copying machine, by enlargement, to the copying of drawings. The pencil drawing, being "gone over" with the ink, was damped on the back till the ink was shiny. Another sheet of damped drawing paper was placed on it, the two were passed through the rollers and a reverse copy was obtained. He stated that a large proportion of the 36,000 to 40,000 drawings were made in this manner and reinked and colored if necessary for stock.

It would not be just to conclude this article without reference to the courtesy of the firm of Tangyes, Ltd., Birmingham, who allowed the writer the major part of a day in their Watt museum, and supplied photographs, or without thanking Harold Baker, head of the machine-tool department, and R. W. Kirton, curator, for guidance to the contents of this unique and invaluable collection of epoch-making relics.

The Causes of Boiler Explosions

By C. A. Schranz

Although the initial causes of most boiler explosions are insignificant in themselves, they are always followed by certain actions within the boiler which are responsible for the disastrous results.

The circumstances causing the explosion of steam boilers were for a long time not definitely understood and were attributed to one or another of the following reasons:

Electricity supposedly produced by friction of the water on the boiler plates.

The rapid generation of steam due to an unknown chemical property of the water.

Oxyhydrogen gas supposed to be generated by decomposition of the water in the boiler.

Spheroidal condition of the water, etc.

Later researches, however, developed the fact that every boiler explosion is accompanied by two occurrences: First, the steam pressure in the boiler is suddenly reduced by the rapid escape of steam in large quantities; second, the consequent reduction in pressure on the hot water causes it to suddenly flash into steam. While these factors are not the direct cause of the failure of the boiler, they are, nevertheless, attending results which count for the disastrous effects of an explosion.

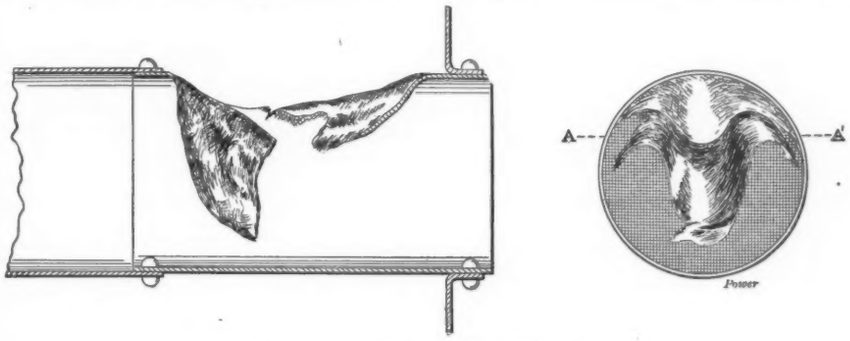


FIG. 1. EFFECT OF LOW WATER

To obtain an idea as to how much water is thus suddenly converted into steam, consider a boiler working under a steam pressure of 142 pounds per square inch, gage, in which case the steam and water each are at a temperature of 361 degrees Fahrenheit. According to the steam tables, the total heat in a pound of dry and saturated steam at this pressure and temperature is 1192 B.t.u. Assuming that it requires one B.t.u. to raise one pound of water one degree Fahrenheit at any temperature, the weight of steam generated from each pound of water in the boiler by the sudden reduction in pressure, will be

(*Temperature of water — temperature corresponding to reduced pressure*) ÷ (1192 — *temperature corresponding to reduced pressure*).

Substituting the numerical values for these quantities,

$$\frac{361 - 212}{1192 - 112} = 0.152$$

pounds of steam of 212 degrees. This means that 15 per cent. of the water evaporates due to the relieved pressure, and 85 per cent. remains in the boiler. Actually, much less water would remain, because, owing to the rapid generation of steam, water would be carried off by it and only about 65 per cent. would remain in the boiler.

The violence of the explosion depends principally upon three factors, viz: the size of the water space of the boiler, the steam pressure previous to the explosion and the size and position of the rent caused by the explosion. If in a boiler with a large water space, a sudden reduction in pressure takes place, the large quantity of water which is thus relieved of the pressure will generate large quantities of steam, which, of course, will do more damage than a smaller amount of steam. If the steam pressure previous to the explosion were high, the corresponding temperature of the water would also be high and more heat would be given up, thus generating a larger amount of steam. But of still greater influence is the position and size of the crack allowing the steam to escape. If for some reason a boiler ruptures in its upper part, its position will change very little or not at all, depending entirely upon the fastenings and supports. On the other hand, should a boiler rupture in the lower part, it would tend to revolve or fly into the air.

The sudden reduction of steam pressure sufficient to cause the disastrous effects of an explosion can only take place when the boiler ruptures. These ruptures, which are the initial cause of all explosions, may be due to the following causes:

Overheating of the furnace or tubes, due to shortness of water, or less frequently to the accumulation of scale.

Overheating of the shell plates of externally fired boilers due to the accumulation of scale.

Oil in the feed water.

Corrosion or wear and tear.

Improper design or poor workmanship.

Resistance to ebullition.

Excessive pressure.

Considering the above causes in their respective order, shortness of water may be due to a defective feeding apparatus, careless opening of the blowoff valve, or to leaky joints. It may also be caused indirectly through defective water gages; for if the lower cock on a water gage is clogged the latter will indicate a proper water level although the boiler may be short of water. When shortness of water occurs, part of the heating surface becomes hot and cracks. The reason for this cracking may be twofold; either the diminished strength of the hot plates cannot resist the existing steam pressure, or else these plates again come in contact with colder water and the sudden generation of large quantities of steam causes a shock which the weakened condition of the plate cannot withstand. The water may come from the feeding apparatus or be thrown on the red-hot plates by ebullition. Fig. 1 shows the effect of shortness of water on an internally fired boiler and the dotted line *A A* indicates the water level at the time of the accident.

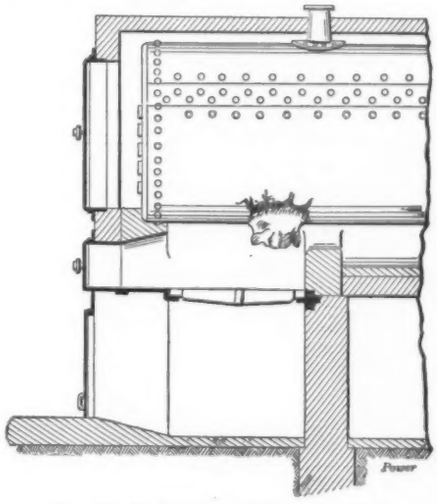


FIG. 2. RUPTURE DUE TO SCALE

The accumulation of scale prevents the water from keeping the boiler plates comparatively cool and therefore results in the same effects as shortness of water. Fig. 2 shows an externally fired boiler damaged on account of scale.

If oil or greasy matter is carried over

with the feed water into the boiler, it will float on the surface until the water is drained off, then it will settle on the plates. In the course of time, the deposit forms a heavy coating which is a very bad conductor of heat and therefore has the same effect as scale.

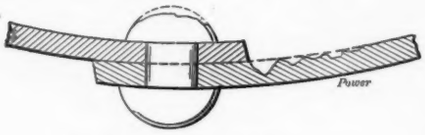


FIG. 3. INTERNAL CORROSION

Corrosion can occur either on the inside or the outside of a boiler. If it takes place on the inside, it is due to air being carried into the boiler with the feed water and deposited upon the plates, thus causing oxidation. Fig. 3 shows a typical example of internal corrosion. External corrosion, however, is more frequent and is usually caused by leaky joints. It is more dangerous than the former and it will affect the boiler as shown in Fig. 4. It is clear that boilers thus weakened are very liable to rupture at these places. Sometimes it happens that an old boiler, apparently in good condition and showing no external signs of weakness, cracks, the reason for which has been traced to a change in the structure of the material.

It is beyond the scope of this article to mention all the defective features in the design and construction of boilers, and therefore only the defects which occur most frequently will be noted.

Very important is the staying of flat heads of internally fired boilers. Where the stays are too weak, the heads will bulge out when under steam pressure

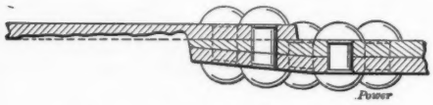


FIG. 4. EXTERNAL CORROSION

and spring back again when relieved of the pressure, this continuous working often leading to a break. On the other hand, if the heads are too rigid they will not allow the hotter tubes to expand sufficiently and a collapse of the latter often results.

Regarding the resistance to ebullition, if water is kept perfectly quiet it can be slowly heated 80 degrees beyond the boiling point without increase of pressure. But the least disturbance at the surface will force the water to evaporate suddenly and cause a shock which may result in the bursting of the boiler. The fact that many explosions occur just at the moment of opening the steam valve in the morning or after the noon hour seems to support this theory. Before opening the valve the boiler is usually under full pressure, but owing to the valve being closed the water is quiet and therefore is able to absorb much more heat than that corresponding to the pressure shown at the steam gage. But when the valve is opened the sudden efflux of the steam disturbs the surface of the water, and the latter being in a superheated condition immediately flashes into steam.

Excessive pressure may be caused either by overweighted safety valves or through their not being in working condition, due to rust or friction which prevents the movement of the lever or springs.

Having described the causes of boiler explosions it may readily be seen that there is nothing obscure regarding them, and nearly every accident of this kind may be easily explained.

Formulas for Designing Engine Parts

By Prof. Albert J. Becker

The use of a great variety of formulas in the design of engine parts has led to many inconsistencies in construction. To avoid these and to establish, if possible, a standard for such design, a new set of formulas has been developed, which are simple and conform to the best current practice.

The great variation in the results attending the use of numerous formulas for the design of engine parts has led to the development of several new formulas in which the mathematical expressions have been reduced and modified by comparison with current practice as found in the best shops. In every case this gives a fairly simple equation which can be solved readily.

These formulas have been used in the machine-design classes of the University of North Dakota for some time and are here presented with the hope that they will be of service to others.

CRANK PINS

$$l\, d^{\frac{3}{2}} = 0.000171\, p\, D^2 \sqrt{N + 75}$$

or, with the usual condition of length equal to diameter,

$$l^{\frac{5}{2}} = 0.000171\, p\, D^2 \sqrt{N + 75}$$

PISTON RODS

$$d = 0.0123\, p\, D^2 \begin{cases} + 0.40 \text{ inch for engines of high rotative speed.} \\ + 0.60 \text{ inch for engines of low rotative speed.} \end{cases}$$

CRANK SHAFT

$$d = 7.25 \sqrt[3]{\frac{I.H.P.}{N}}$$

CONNECTING ROD

For round rod, center dimensions,

$$d = 0.032 \sqrt{D\, L\, p^{\frac{1}{2}}}$$

while at the wristpin end

$$d = 0.011\, D \sqrt{p}$$

For rectangular rod, center dimensions,

$$h = 0.04 \sqrt{D\, L\, p^{\frac{1}{2}}}$$

At small end,

$$h' = 0.015\, D \sqrt{p}$$

$$t' \text{ (constant)} = 4/9\ h$$

The small dimensions given are a minimum and should be increased whenever necessary to obtain a properly proportioned tapered rod.

RECTANGULAR FORGED CRANKS FOR CENTER CRANK ENGINES

$$w = 2b = 0.5\ D$$

CYLINDER WALLS

$$t = \frac{p\, D}{4000} + 0.6 \text{ inch}$$

FLYWHEEL ARMS

$$a = 2\, c = \sqrt[3]{\frac{1200\ I.H.P.}{n\ N}}$$

The cross-section at the rim equals three-quarters of the hub cross-section.

The notation used in the above formulas is as follows:

p = Maximum pressure in the cylinder in pounds per square inch.
D = Diameter of cylinder.
d = Diameter of part considered.
l = Length of crank pin.
L = Length of connecting rod.
N = Revolutions per minute.
$I.H.P.$ = Indicated horsepower.
a = Width of flywheel arm in plane of wheel.
c = Thickness of flywheel arm.
n = Number of spokes in flywheel.
w = Width of crank arm perpendicular to shaft.
b = Thickness of crank arm.
t = Thickness of cylinder walls.
t' = Thickness of connecting rod.
h = Hight of connecting rod at center.
h' = Hight of connecting rod at small end.

All dimensions are in inches.

Ball Bearing Lineshaft Hangers*

By Henry Hess

The inadaptability of the various types of hanger to the use of ball bearings necessitated the design of a special hanger which is herein described and illustrated. By the use of this hanger the friction loss is reduced nearly one-half.

In first applying ball bearings to line shafts, such hangers as were on the market were employed; but it was soon found that these were not adaptable and a special hanger had to be designed. The points kept in view in this design were as follows:

Definite support of the box on machined seats permitting no shifting under load.

Ability of the box to swivel in all directions.

Vertical and horizontal adjustments of the box within the hanger body.

Rigidity in all directions.

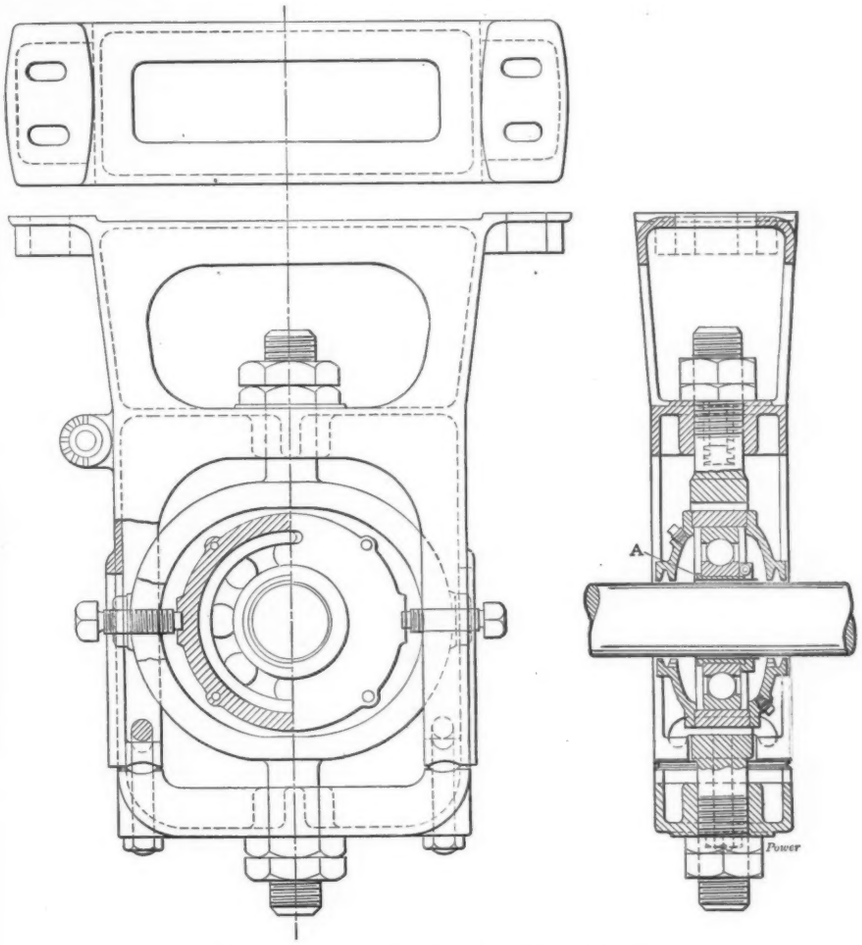
Convenience of adjustment in alining the shaft.

Adaptability for countershaft hangers involving a shifter arm.

Neatness of general outline and conformity to modern machine design by substituting box sections for ribbing.

Lowest cost consistent with other requirements.

The design as finally evolved is shown in the accompanying illustration. The box is supported and pivoted horizontally on the ends of two screws tapped through the opposite sides of a yoke surrounding the box, with enough freedom to give one inch of horizontal adjustment. This yoke has an upper and a lower cylindrical stem, each turned to a running fit in the corresponding bore of the hanger; these stems are threaded and provided with nuts and check nuts and allow a vertical adjustment of 2 inches.



ARRANGEMENT OF BALL-BEARING HANGER

The hanger body is of channel section and is stiffened by the central crossbar which carries the weight of the box and shaft. The lower crossbar is cast integrally with the hanger body and is split off in the usual way. A single drop-forged ball-ended T-bolt serves for attachment at each end.

The bearing box consists of a central supporting ring bored to a close fit for the outer race of the ball bearing. To the side faces are bolted cover plates with an oil-tight joint and where these surround the shaft they are provided with a cored annular groove. The side lips are bored 1/64 inch larger than the shaft diameter and have sharp edges. This arrangement is found to be efficient in retaining the lubricant and preventing the entrance of foreign matter.

The ball bearings are free to move endwise in the box. It is recommended that a line shaft be held endwise by ordinary collars on either side of the central hanger so that all weaving is allowed for by the end freedom in the boxes. Unusually heavy thrusts are provided for by special hangers into which a collar type of ball bearing is built.

As it is necessary to clamp the ball bearing to the shaft so that the inner race cannot rotate, and as commercial shafting is somewhat indeterminate in size, an "adapter" is employed. This consists of a bush *A*, fitting into the bore of the inner race, which, in turn, is fitted with a coned split sleeve. This latter is driven home endwise until the whole is tightly clamped onto the shaft. Unless there is considerable vibration, the wedging effect of the small angle of the conical bush is sufficient to prevent any loosening, but to guard against all contingencies a split collar is clamped onto the sleeve with its face close to the face of the bearing.

The ball bearing itself is a simple element, consisting of an inner race, an outer race and a single row of interposed balls. The races and balls are made of alloy steels (a special mixture of the carbon, chrome and manganese varieties).

Ball bearings can be used with as much safety and reliability at 600 revolutions per minute as at 200, whereas the use of such high speed with plain bearings is beset with so many difficulties in the way of reduction in size of line shaft, pulleys, drop hangers, etc., as to take it practically out of consideration for the average plant. Moreover, the first cost of a ball-bearing installation at 600 revolutions compares favorably with that of plain bearings at 200 revolutions, and is very apt to be less.

From actual tests, the use of ball bearings has been found to cut the friction loss down to nearly one-half.

*Abstract from paper delivered before the American Society of Mechanical Engineers.

It is reported that on June 3 a boiler explosion at the Midvale Steel Works, Cambria, Penn, killed two men and injured half a dozen more.

Ice Making and Refrigeration

By C. P. Wood

The direct-expansion and the brine systems of refrigeration and the two ways of making ice commercially, the plate and can systems, are touched upon briefly by the author. The economy of combining an ice plant, electric plant and cotton seed oil mill is also considered.

Refrigeration is accomplished by two systems: Direct-expansion, in which the gas expands directly in coils situated in the refrigerating rooms; and the brine systems, in which the ammonia-expansion coils cool brine, which in turn is circulated in refrigerating coils.

Direct expansion is better in large plants continuously operated. Long-distance refrigerating lines use ammonia under pressure in the mains, with expansion valves at the points of distribution.

In the brine system the refrigerating medium can be kept in circulation while the compressor (or absorption machine) is shut down. This is a great advantage when repairs are necessary or when the brine alone will keep the refrigerators at a sufficiently low temperature during the night, making it possible to do without a night engineer at the plant. In the can system of ice-making, the same brine used in the tank can be pumped around through the refrigerating coils. This makes it economical to have cold-storage rooms in connection with a small ice plant, when with direct expansion it would not pay. The boiler fires can be banked at night, holding enough steam to run the brine-circulating pump.

Refrigerating brine is made from either NaCl or $CaCl_2$; the latter is preferable because of less friction in pipes, lower freezing temperature, and no injurious effect upon iron. A good proportion is 2½ pounds of $CaCl_2$ per gallon of water.

Artificial ice is made in two ways commercially: The plate system and the can system. In the plate system, a hollow iron plate containing coils in which the freezing medium is circulated is immersed in a tank containing the water to be frozen; ice is formed on the outer surfaces. The average size of cake is 16x8 feet by 11 inches, requiring about ten days for freezing. After harvesting, the cakes are sawed up into the size required by the market. This system makes clear ice, because, if the water is clear enough for drinking purposes, it will in process of freezing free itself from the impurities which are on the surface and which make the cloudy core in can ice. There are several methods of loosening the cakes from the plates; with direct expansion, hot ammonia circulated through the coils will loosen the cake in a little while. Except in small plants, when good drinking water is available the plate system is cheaper than the can system. It is, however, more expensive to install and requires more care in operation.

In the can system, the water to be frozen is held in conveniently shaped cans of galvanized iron suspended in a tank filled with brine. The brine is cooled by coils in which expanding ammonia circulates. Can sizes vary from 8½x15x32 inches for a 100-pound cake to 11x22x44 for a 300-pound cake. This allows 5 per cent. for thawing. To make clear ice the brine temperature should be from 15 to 20 degrees and the time for freezing 300-pound cakes from fifty to sixty hours. Two hundred-pound cakes can be frozen in a little less time and 100-pound cakes can be frozen in thirty-six hours. The brine must be kept in agitation; the agitator is either a propeller or a pump drawing from one part of tank and discharging into another part. Distilled water is necessary to make clear ice by the can system. Too rapid freezing makes snowy ice. Air in the water makes a cloudy core in the cake. Impurities make a muddy cake. Distillation should occur under not less than 90 pounds pressure. After condensation, the water should be reboiled, skimmed, filtered and cooled before being placed in the cans. When exhaust steam is used it is passed through a steam filter to remove the oil.

The condensed distilled water contains air in solution and sometimes other volatile substances possessing objectionable flavors. To free it from these and to cause other impurities to rise to the top and be skimmed off, the water is subjected to vigorous reboiling in a separate tank. The reboiler is generally an iron tank containing a steam coil; there is a waste overflow at the top to allow impurities which rise to float off, to accomplish which the tank is kept running over a little. The skimmer is a tank between the reboiler and the cooler; it is kept running over a little to carry off impurities that rise to the surface. After passing through the cooling coil, the water is filtered in a filter made of sand and charcoal, bone black or some other absorbent substance. The tank in which the water is kept for filling the cans should contain an ammonia coil to cool the water further. Between this tank and the cans the water should be passed through a sponge filter to catch those substances that coagulate in cooling. The red core sometimes seen in ice is due to oxide of iron. This can be removed by filtering at 38 degrees, at which temperature it is precipitated.

Economy of Combining an Ice Plant, an Electric Plant and a Cotton-seed Oil Mill

The busy ice season lasts about six months of the year. In considering the necessary size of a plant there is a question whether to install machinery that will have an output large enough to keep up with the demand, making it necessary to operate only during the ice season, or to do with a smaller plant that will have to be operated the year round, storing the ice in winter. If other employment can be found for the engineers and working force of the plant, it is more economical to operate the larger installation, shutting it down during the winter. It has been claimed that the cooler condensing water available in winter makes ice manufacture enough cheaper to make up for the loss in storage, but this advantage is overcome by the increase in consumption of coal due to the cold draft in the boiler furnace.

The cottonseed-oil season lasts from about October until April, the same months during which the ice plant is usually dormant. Oil mills run day and night, as do ice and electric plants. The machinery in these mills consists of linters (small cotton gins), heavy hydraulic presses, revolving screens and grinding machinery, all of which can be driven by electric motors.

The engineering and office forces required to run a combined ice and electric plant would not have to be materially increased for the addition of an oil mill, provided the men were familiar with that business. There would have to be more common labor, but this is hired by the day and does not have to be retained when not needed. There would be a saving of fuel, because the load would not be subject to wide variations, which lower the efficiency of the boilers. The ice plant could be shut down in case a sudden increase of the electric load should temporarily overtax the boilers, and the oil-mill load could be lightened a little while to meet a similar emergency.

Except in comparatively small installations, it would not be advisable to drive the ammonia compressor by electricity, but the oil-mill machinery is particularly adapted to electric drive. This makes it possible to generate all the power in the same engine room, a very desirable feature. The special conditions governing the operation of a plant would determine whether to drive the mill with a separate unit or to install a unit large enough to handle the lighting load and the mill at the same time. The lighting current would be generated at either 6600 or

2200 volts, most likely, which would have to be transformed down to 220 or lower for distribution to the motors in the mill. Three-phase 60-cycle motors of the induction type are excellent for oil-mill work. The best practice would be to intall two units of the same type with connections allowing the machines to be operated independently or in parallel, with either load on either machine. There would be a slight transformer loss due to stepping down the mill current instead of generating it at the required voltage, but this would be made up for by the mutual availability of the machines in case of a breakdown. These remarks are on the assumption that one machine could handle the electric load, otherwise they apply to any number.

The combination of an ice and electric plant is a practical proposition in almost any locality; the addition of an oil mill would be possible only in the cotton-producing section of the country.

Piston Controlled Exhaust Ports

By F. L. Johnson

Thirty odd years ago an American patented a central exhaust port for steam cylinders. Quite recently the application of the same idea has been patented in Bohemia and Germany. In some of these the central exhaust port operates in conjunction with separately actuated exhaust valves, and in some there are no other means of exhaust control.

In the simpler forms of the two-cycle gas engine the piston as it approaches the end of the outward stroke uncovers an opening in the side of the cylinder through which the spent gases make their way to the outside, while from the other side of the cylinder through another opening a charge of fresh gas enters. Early in the return stroke the piston passes over the openings in the cylinder wall, shutting in nearly a cylinderful

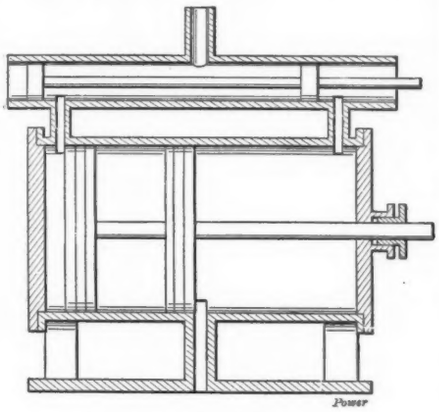


FIG. 1. AMERICAN PATENT

of gas and compressing it to a pressure depending on the percentage of clearance in the cylinder.

Though openings in the cylinder wall controlled by the piston seemed to make an ideal exhaust opening for the gas engine the arrangement has not been extensively adopted in steam-engine design. But that such design is of some utility has been the thought of more than one inventor.

In 1872 there was patented in the United States an improvement in reciprocating steam engines which consisted of an opening through the cylinder wall at or near the middle of its length and at the bottom. As the piston approached the end of its stroke the opening was uncovered, allowing the water and the steam that had not already left the cylinder by the way of the port at the top of the cylinder to run out at the bottom. This arrangement is very clearly shown in Fig. 1.

This single application of a piston-controlled exhaust port seems to have satisfied the American inventor and for 30 years the idea slumbered peacefully in the archives of the patent office, but it has been given a new lease of life and possibly some activity by three applications abroad, one by Messrs. A. Schulz and E. Posmourney, Koniggratz, Bohemia,

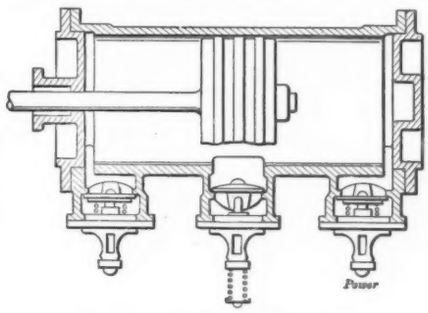


FIG. 2. BOHEMIAN PATENT

Austria, and two from Berlin, Germany, the latter being inventions of Prof. Johann Stumpf. In the Bohemian patent, Fig. 2, it will be seen that the exhaust valve in the middle port of the cylinder may open at any portion of the stroke and remain open as long as is desired, and that although the piston may uncover the port quite early in the stroke, the exhaust valve may remain closed for a period that will carry expansion to the end of the piston travel if desired. But on the return stroke, however long the valve may remain open, the port will be closed by the passing of the piston over it at near half-stroke.

In the first of the Stumpf designs, Fig. 3, there are beside the plurality of exhaust passages through the cylinder walls reciprocating exhaust valves controlling the exhaust until the piston passing over the openings closes the communication between the cylinder and the exhaust passage.

In the second Stumpf design, Fig. 4, the multiple-exhaust openings communicate directly with a circumferential passage to the outside without exhaust-valve control of any kind, and the exhaust

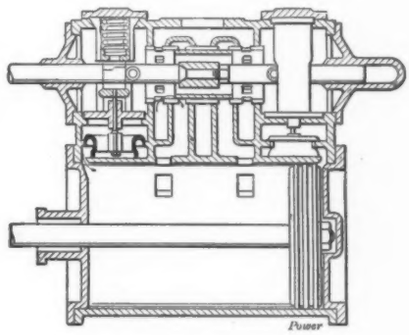


FIG. 3. FIRST STUMPF DESIGN

is closed almost as soon as opened by the long piston which lacks only the width of the exhaust port of being one-half the length of the cylinder. Excessive compression is avoided by providing large clearance spaces in the cup-shaped piston ends. This design is intended for locomotive-engine cylinders where it is desirable that the steam-inlet valve be held open at both ends of the cylinder when running under no-load conditions with a closed throttle, the contents of the

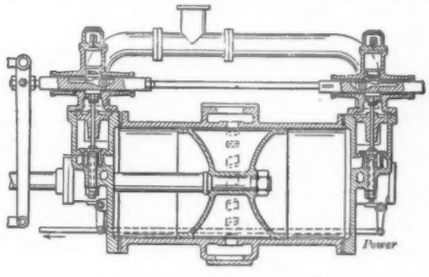


FIG. 4. SECOND STUMPF DESIGN

cylinder passing from one side of the piston to the other through the steam valves which are held open by the bell cranks which are operated by rods and levers controlled from the cab.

Electrical Department

An Improved Absorption Dynamometer *

The following points are desirable in a dynamometer; their importance corresponds to the order in which they are enumerated:

Freedom from binding or "seizing."

Freedom from changes in load due to changes in the apparatus itself, such as change of temperature, wear or friction of parts.

Ability to absorb and accurately indicate widely varying loads.

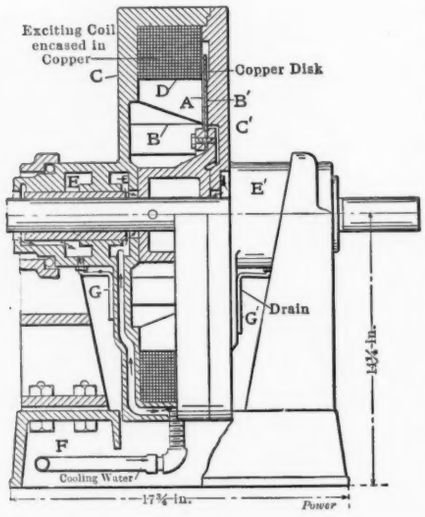
Positive and instantaneous regulation of load.

Minimum demand for attention.

Capability of continuous service.

Self-contained construction.

Small amount of floor space required.



END ELEVATION AND PART SECTION

Freedom from noise and splashing of oil and water.

Capability of being changed quickly from one prime mover to another.

Small amount of cooling water required.

A machine which fulfils these requirements to a desirable degree is described herewith. It is based upon the principle of magnetic induction. When a conductor is revolved in a field of variable magnetic intensity an electric current is induced in the conductor. The reaction of this current upon the field that produces it causes a torque between the conductor and the field.

There are two ways of dealing with the current induced in the conductor. The current may be collected by a commutator or by slip rings and carried away from the machine; or it may be allowed to remain, and, circulating in the path of least resistance, it will ultimately short-circuit itself and produce heat.

*Abstract of paper presented before the American Society of Mechanical Engineers, at Atlantic City, N. J., May 31-June 3.

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

In the first case we have simply a dynamo mounted in a cradle. This serves as a very effective and satisfactory type of dynamometer. There are, however, objections to its use. The currents generated may be taken care of either by water rheostats or lamp banks, or utilized in the performance of work. Water rheostats and lamp banks require considerable attention and occupy space. Owing to irregularities in testing, the utilization of the currents for the performance of work is in most cases impracticable. The initial cost of a testing unit of this kind is necessarily large.

If the currents in the conductor are permitted to short-circuit themselves the conductor is heated; the amount of heat produced is equivalent to the work absorbed by the dynamometer; and the heat thus generated may then be carried off by cooling water. This is the principle utilized in the design herewith illustrated.

The dynamometer consists of a metallic disk revolving between a set of pole pieces so constructed as to produce a magnetic field of variable intensity. The accompanying engraving shows an end elevation and a partly sectional view. A copper disk *A*, mounted on a bronze hub, revolves in front of pole pieces *B B'*. The magnetic circuit is made up of a casting *C*, the air gap and the cover plates *C'*. The casting *C* and *C'* are bolted together and carry the exciting coil *D* and the bearings *E* and *E'*. The magnetic yoke made up of castings *C* and *C'* carrying the field coil and disk, is supported in ball bearings, and is prevented from rotating with the disk by a spring balance. The latter measures the pull or torque between the rotating disk and the magnet.

The magnetizing coil is incased in copper, the terminals being carried out through holes in the casting *C*, which are carefully sealed after the coil is in place.

The heat generated by the short-circuiting of the eddy currents generated in the copper disk is carried off by the cooling water which enters through the base connection at *F* and passes up through the bearings into the field casting. It then passes out through openings which are not shown in the illustration. This water not only carries off the heat generated, but serves as a lubricant for the bearings. That which passes through accumulates in the central chamber *E*, and is discharged at the base of the machine through the drains *G G*. The machine is designed with six poles.

In operating, the engine under test is directly connected to the dynamometer shaft by means of some form of flexible coupling, the cooling water is turned on and the engine is started. After normal speed is reached, the load may be thrown on by energizing the field coil. The amount of current and consequently the torque or pull on the spring balance is regulated by a rheostat connected in series with the coil. After running a few minutes, the quantity of cooling water is adjusted so that the temperature of the machine does not exceed 150 degrees Fahrenheit. In larger machines the coil may be wound with asbestos-covered wire and the temperature permitted to reach 212 degrees, so that the cooling water is evaporated within the dynamometer. This reduces the quantity of cooling water required about 75 or 80 per cent.

The normal working temperature having been reached, the load on the machine remains absolutely constant, provided the line voltage is constant, for the mechanical friction, which is the bearing friction of the revolving disk, is small and practically constant, and changes in temperature due to changes in the supply of cooling water also affect the load on the dynamometer very little. The regulation by the rheostat is instantaneous and positive.

In the case of the present machine the torque is almost proportional to the speed and is maximum at about 600 revolutions per minute. From this point the torque drops off about 15 per cent. at 1200 revolutions, and remains almost constant from 1200 to 1500 revolutions per minute.

The torque depends upon the speed, number of poles, thickness of air gap, thickness of the copper disk, shape of the copper disk, and shape and spacing of the pole pieces. By varying the number of pole pieces and the thickness of the copper disk, the point of maximum torque on the speed-torque curve may be shifted anywhere from 25 to 2500 revolutions per minute.

Catechism of Electricity

Motor-Generators, Dynamotors and Rotary Converters

1117. *What distinction is there between these three types of machines?*

A motor-generator consists of a motor, either direct-current or alternating, direct connected to a direct-current or alternating-current generator, both motor and generator being usually mounted upon a single base, as in Fig. 356. Of these possible combinations that of an alternating-current motor direct connected to an alternating-current generator is practically never used because a transformer would answer the purpose in a much cheaper and simpler manner.

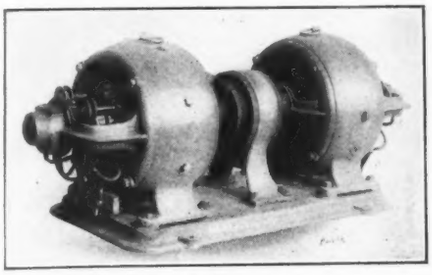


Fig. 356. Small Motor-Generator Set Built by the Northern Electric Manufacturing Company

In a dynamotor, two armature windings are put on one core and a single field-magnet frame suffices, as in Fig. 360. One of these windings is a motor winding and the other a dynamo winding, and either or both of them may be for either alternating current or direct current. Two alternating-current windings are never used, however, for the same reason as above, namely, a transformer is simpler and cheaper.

A rotary converter has only one armature winding, which is connected to a commutator exactly like a simple direct-current machine, but is also connected to collector rings like a closed-circuit alternating-current armature winding would be. A converter can either receive direct current and deliver alternating, or the reverse. It cannot deliver the same kind of current that it receives.

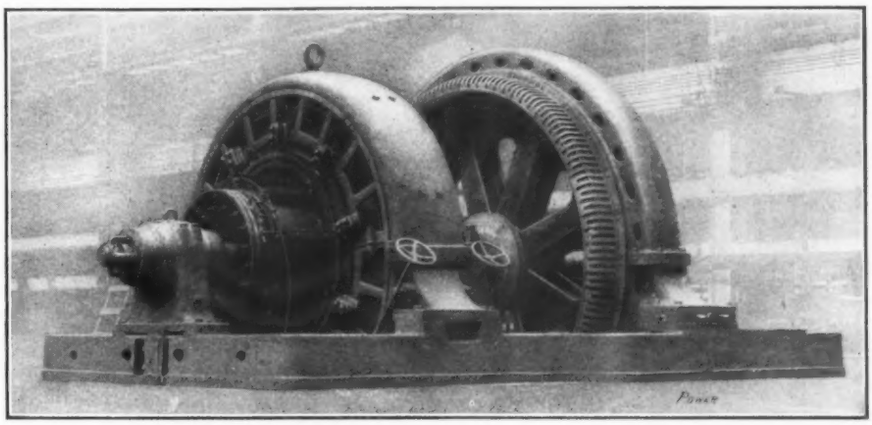


Fig. 358. Large Westinghouse Motor-generator Set

118. *Under what conditions are the different machines used?*

When there is considerable difference between the voltage it is intended to deliver to the machine and that which it is desired to obtain from it, or when the delivered voltage must be varied considerably, the motor-generator type is preferable because of the better opportunity for insulating the high-potential circuit from the low-potential one, and because the dynamo voltage can be adjusted independently of the motor voltage.

Motor-generators are extensively used as boosters in electric lighting. On long lines the drop of potential may be such as to make the voltage for lamps at a distance from the station too low for securing the same illumination as in lamps near the station. In such cases a motor-generator is connected at the motor end to the station busbars from which the main lines lead, and the field and armature windings of the generator are connected in the feeder circuit in series so that the field strength increases as the load on the feeder increases and the armature adds greater pressure in proportion. This boosting effect on long lines is such that the added voltage is enough to compensate for the large drop in the line.

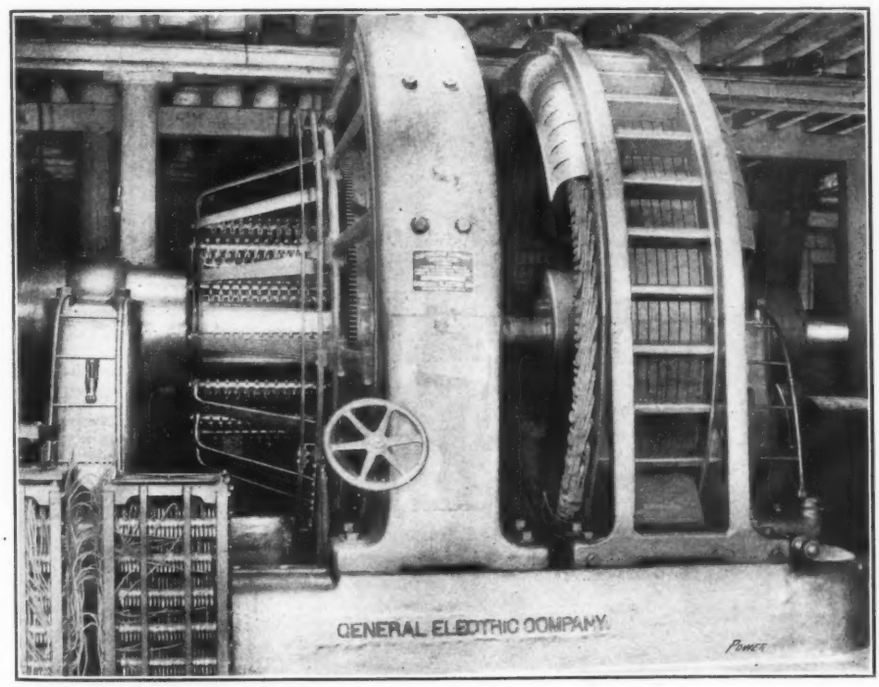


Fig 357. Induction Motor and Direct-current Generator

Dynamotors and rotary converters are more efficient, simpler in operation, more compact and cost less than motor-generators so that they are preferable when the voltage difference is not great and the dynamo voltage does not need to be varied—widely. For charging storage batteries, furnishing ringing current in telephone exchanges, supplying current for testing or experimental work of various kinds in which no great flexibility of voltage regulation is required, and for other purposes requiring small current output, the dynamotor is largely used. The use of the rotary converter is chiefly in substations where it converts the alternating current sent from the central generating station into direct current for distribution.

1119. *Under the conditions just described, is there not a great difference between the alternating- and direct-current voltages handled by the converter?*

There would be considerable difference if the voltage of the incoming alternating current was not reduced by means of step-down transformers before being applied to the rotary converter. There is a fixed ratio that exists at all times between the alternating-current voltage and the direct-current voltage of a rotary converter, and the direct-current is al-

ways the higher of the two. The alternating voltage of a single-phase converter is about 70 per cent. of the direct-current voltage; that of a two-phase converter is about the same and that of a three-phase converter about 60 per cent.

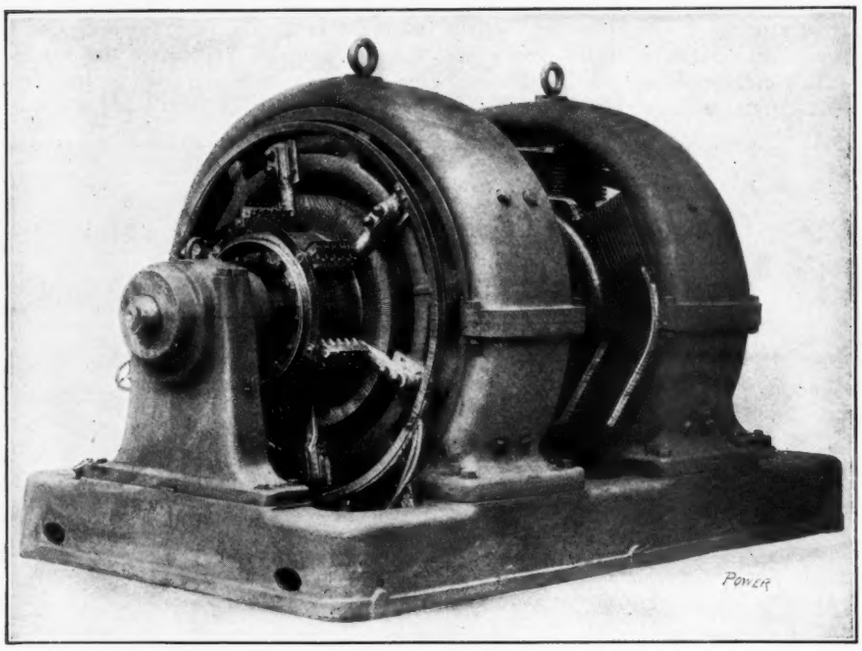


FIG. 359. WESTINGHOUSE MOTOR-GENERATOR SET USED AS A BOOSTER

1120. *Describe briefly the differences between the motor-generators shown in Figs. 356 to 359.*

The motor-generator in Fig. 356 consists of a direct-current motor driving a small alternator. The coupling between the two armature shafts runs in a pedestal bearing, which is a very unusual arrangement. This machine, which was built by the Northern Company, is small in comparison with the General Electric motor-generator, Fig. 357, and the Westinghouse sets shown in Figs. 358 and 359.

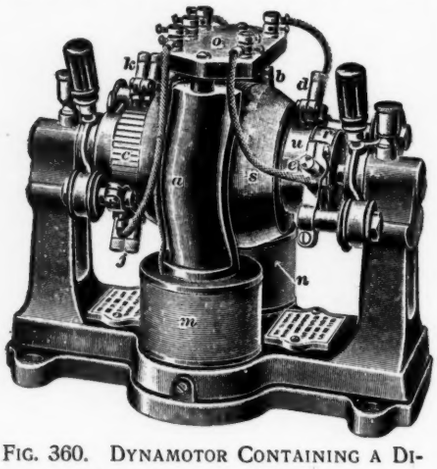


FIG. 360. DYNAMOTOR CONTAINING A DIRECT-CURRENT MOTOR WINDING AND AN ALTERNATING-CURRENT GENERATOR WINDING

The outfit in Fig. 357 consists of an induction motor of 1400 horsepower, driving a shunt-wound direct-current generator of 1000 kilowatts capacity.

The distinguishing feature of the set in Fig. 358 is the generator, which is of the three-wire type, of 1000 kilowatts capacity. The machine in Fig. 359 is a motor-generator booster set comprising a 365-horsepower, direct-current, shunt-wound motor (at the left) and a 250-kilowatt, direct-current, series-wound generator.

1121. *Describe the machine shown in Fig. 360.*

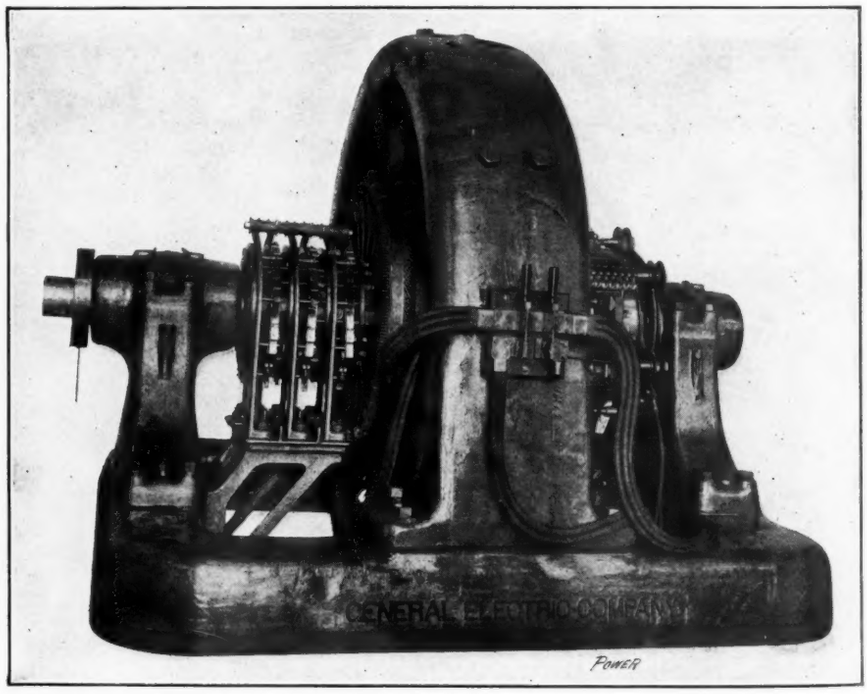


FIG. 362. ROTARY CONVERTER

This machine is a dynamotor with a direct-current motor winding and an alternating-current generator winding. It is built to run as a motor on a direct-current main and deliver alternating current for ringing purposes. The field-magnet coils *m* and *n* of the two-pole magnet are excited by direct current from the supply circuit. The direct current or motor end of the machine is at the left, as indicated by the commutator at *c*, and the alternating current or generator end of the machine is at the right, as indicated by the collector rings at *u* and *r* The two armature windings are electrically separate although they are upon the same core.

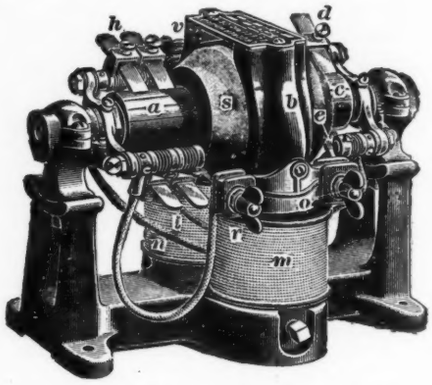


FIG. 361. DYNAMOTOR WITH DIRECT-CURRENT MOTOR AND GENERATOR WINDINGS

1122. *Describe the dynamo shown in Fig. 361.*

This machine is provided with a direct-current motor winding and a direct-current generator winding, the difference being only in voltages. It was built for charging small storage batteries, the voltage required for this purpose being usually much less than that of the sup-

ply circuit from which the dynamotor is operated. The coils *m* and *n* of the field magnet *v b* are excited with direct current from the electric light or power wires to which the machine is connected. The commutator *c* is on the motor end and the commutator *a* on the generator end, the brushes *d* and *e* taking current from the service wires, and the brushes *h* and *i* delivering current for charging the battery.

1123. *Describe the machine shown in Fig.* 362.

This machine is a rotary converter of 750 kilowatts capacity at the direct-current end. It is built to take six-phase alternating currents of either 25 cycles or 60 cycles frequency and deliver direct current at 600 volts. The six-phase alternating current is obtained by special connections of transformers supplied from a three-phase circuit. The field magnet is compound wound for use where the load is variable, as in interurban-railway systems, to compensate automatically for the drop due to line, transformer and converter impedance. A speed-limiting attachment, which automatically opens the direct-current circuit-breaker when the speed of the machine exceeds a predetermined value, is attached to the converter armature shaft at the collector-ring end. This is to provide against possible damage from excessive speed such as might occur if the alternating power should be shut off, and direct current from that system should drive the machine as a differential motor, which would weaken the field excitation and cause abnormal speed.

LETTERS

Chattering Brushes

I believe that a practical discussion among the men who have charge of direct-current dynamos as to the cause for chattering of the brushes would be of interest to a great many of the readers who have these machines in their charge.

In visiting power plants in various parts of the country, I have noticed that this trouble seems to be very common, and does not seem to be confined to any particular make or type of machine, but is common to a great many direct-current machines using carbon brushes. In many cases the trouble is great enough to interfere seriously with the equalizing of the load between machines operated in parallel; and in most cases the chattering is accompanied by considerable sparking which causes rapid wear of the commutator and brushes.

In case of a machine in which the mica insulation between the segments is too hard, the chattering may be caused by the mica projecting above the segments, due to the copper wearing away faster than the mica. Where very soft brushes are used the chattering may be caused by the tension being too light, the brushes sticking to the commutator and jumping away with a series of rapid vibrations, this action being similar to that which occurs when one pushes the tip of the finger over the wet surface of smooth glass; if the pressure be light, the finger passes over it with a series of short vibrations, while by pressing the finger harder the motion over the surface will be smooth and steady.

Where the brushes chatter with a heavy load they will almost invariably be found to run extremely hot; this can be easily proved by taking one of them out of the holder and feeling of it, one trial usually being sufficient to convince the operator that they are warm. When the machine is not heavily loaded, chattering may take place without causing enough sparking at the tips of the brushes to be noticed, but by looking at them on a line parallel with the commutator, there will be noticed a bright streak of sparks between the ends of the brushes and the commutator, and this sparking will heat the commutator and brushes enough to produce an increase in the drop of voltage between the armature and terminals that will interfere to a considerable extent with the division of the load between machines operated in parallel.

I have known of cases where almost every known remedy had been tried to cure this trouble, without success, and considering the number of men in plants who are up against this same trouble, I think that an exchange of experiences in this Department would result in bringing out some suggestions that might "help some."

S. KIRLIN.

New York, N. Y.

Mr. Brand's "Easy Mystery"

In reading the letter headed "An Easy Mystery" in POWER for May 17, I can only surmise that Mr. Brand's motor had a differential field winding—that is, the series winding and shunt winding were opposing each other. When his lathe and band saw were running, the machine was not using enough current for the series field winding to overbalance the shunt field winding but when the circular saw, which I presume ran at a high rate of speed, was thrown on, the increased current flowing through the series field winding caused this winding to become stronger than the shunt winding, thereby reversing the motor.

At a point where this change occurs there would be practically no field in the motor and the fireworks mentioned would be the result.

JAMES MERRICK.

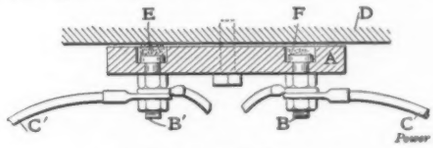
Denver, Colo.

[Mr. Merrick's explanation is the correct one. We have received the same explanation from S. Davidson, Brooklyn, N. Y.; G. A. Glick, Madison, Wis.; P. Justus, Cleveland, O.; C. Kerr, Ft. Monroe, Va.; S. Kirlin, New York; Robert Rogers, Windsor, Conn.; Cornelius Van Genderen, Three Oaks, Mich.; H. B. Wier, Jr., Ft. Smith, Ark., and J. G. Wilson, Girard, Ohio.—EDITOR.]

Very Near a Short Circuit

On taking charge of a small electric plant in the State of Ohio some few years ago, I found one of the generators, which were 220-volt direct-current machines, was grounded. In testing for the ground it was located behind the terminal bolts, as indicated in the sketch, where *A* represents the slate terminal block, which was bolted to the frame *D* of the machine on the inside of the bearing pedestal directly under the commutator. The cables *C C'* from the brushes were connected to the bolts *B B'*, the heads of which were in countersunk holes, as shown.

As the magneto showed a ground on the bolt *B* with the cables disconnected, the block *A* was removed and the conditions shown at *E* and *F* were discovered. The space *E*, between the bolt head and



ACCUMULATING TROUBLE

the frame, was completely filled with oil and copper dust and shavings, which had dropped in between the slate and the frame when the commutator had been turned and sandpapered. The space *F* was nearly full.

R. L. MOSSMAN.

Tampa, Fla.

Care of Rotary Converter Collector Rings

Replying to Mr. Eberhart's inquiry in the issue of May 17, in regard to the care of rotary converter rings in our plant, I would say that it is our practice to slightly smear all collector rings with motor grease before starting. Whenever we detect any ring cutting we again apply the grease by the use of a rag attached to a stick, being careful to apply only a small quantity at a time. With this care we very seldom have a ring cut and the result is an excellent polish on the rings. A frequent cause of these rings cutting is the fact that the copper brushes are set too firmly on the rings. The rings should be kept properly trued up so that the brushes will make good contact with only a slight spring pressure.

Our converters are 750-kilowatt machines.

W. H. RICHARDS.

Brockton, Mass.

Gas Power Department

Gas Power for Central Stations*

By M. Nisbet Latta

Fuel Waste

According to the United States Geological Survey, our present method of burning coal with smoke is costing the people of this country unnecessarily $90,000,000 annually in wasted fuel alone, regardless of railway consumption. It is

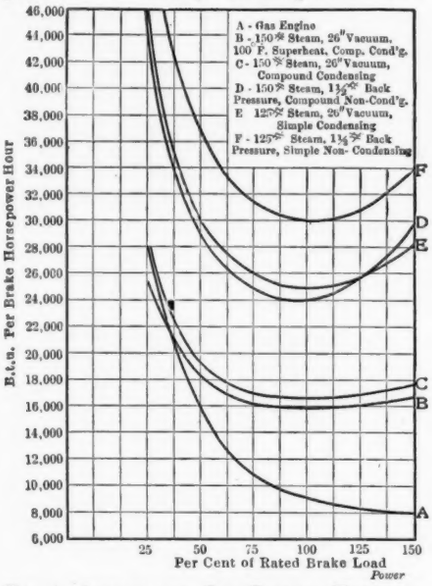

A - Gas Engine
B - 150# Steam, 26" Vacuum, 100° F. Superheat, Comp. Cond'g.
C - 150# Steam, 26" Vacuum, Compound Condensing
D - 150# Steam, 1½# Back Pressure, Compound Non-Cond'g.
E - 125# Steam, 26" Vacuum, Simple Condensing
F - 125# Steam, 1½# Back Pressure, Simple Non-Condensing
B.t.u. Per Brake Horsepower Hour
Per Cent of Rated Brake Load
Power

Fig. 1. Steam and Gas Engine Economy Curves

estimated that 8 per cent. of the coal used in the production of light, power and heat, or in all about 20,000,000 tons of coal, is going up the chimneys each year in smoke. This coal costs the people at least $40,000,000. It is further estimated that in the production of coke 25,000,000 tons of coal, worth $50,000,000, are wasted annually in the coke-oven gases which are allowed to go off into the air. The coke ovens of the Connellsville district alone carbonize more than 100,000 tons of coal per day, and, assuming 50 per cent. volatile, this field alone wastes to the atmosphere, without benefit, return or compensation of any sort, 50,000 tons of fuel a day or its equivalent value.

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

It has been argued heretofore that it was not possible to install central stations in the coke fields by reason of the widely fluctuating demand for coke and the consequent impossibility to furnish continuously any stated volume of power derived as a byproduct. However, the development of the producer is materially and rapidly changing this condition, and by maintaining a battery of producers as a standby it will be possible to supply uniform electrical service with a high degree of commercial efficiency.

Consider, for instance, the possibilities of a ton of coal properly and improperly used, or compared with a ton of coal in ordinary use. It is fair to assume that under average conditions of steam generation a ton of coal costs $2.50 and produces not over 400 horsepower-hours. This same ton of coal carbonized in a coke-oven plant would produce the following values on the present Chicago market:

1200 pounds of coke worth @ $5.50 per ton	$3.30
25 pounds of sulphate of ammonia @ $2.50 per cwt	0.62½
10 gallons of prime tar @ $5.00 per bbl. (50 gals.)	1.00
6000 net cubic feet of gas, equivalent to 240 horsepower-hours	
	$4.92½

This shows a gross margin of $2.42½ per ton, plus 240 horsepower-hours.

Or by another method of operation, by the firing of the ovens with coke instead of gas, we can increase the byproduct of gas to 10,000 cubic feet per ton of coal of an average value of, say, 450 B.t.u., or, in other words, a byproduct of, say, 400 horsepower-hours. This byproduct, over and above all the other products obtained, constitutes a net profit which is in itself as great as the total power which is derived from the combustion of coal as carried out in present practice.

It must not be supposed, however, that the coke ovens are alone in the waste of natural fuel. A recent report by the Geological Survey estimates the fuel waste, due to inefficient methods of combustion in the locomotives of this country, to exceed $180,000,000 a year, in addition to which there is the loss due to cost of transporting water and fuel (probably four mills per ton mile) and the weight of the locomotives themselves, largely exceeding that of electrical motors of equivalent horsepower.

Then there is the waste of fuel by the numerous steam plants in large cities. Some idea of this may be gained from the fact that every twenty-four hours, in Chicago and its environs alone, more than 350,000 tons of coal are consumed, which means approximately a million dollars a day for fuel. An idea of the inefficiency of this combustion may be noted from the statement of the smoke inspector of that city that the estimated damage to mer-

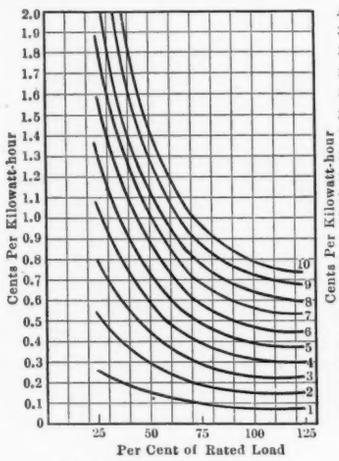


Fig. 2. Producer Coal Costs

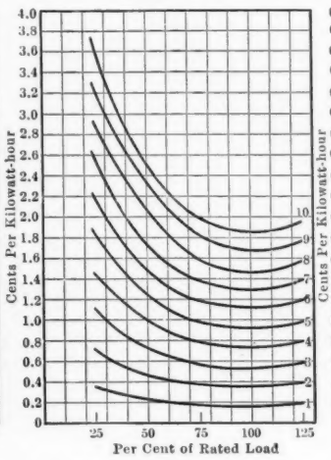


Fig. 3. Steam Coal Costs

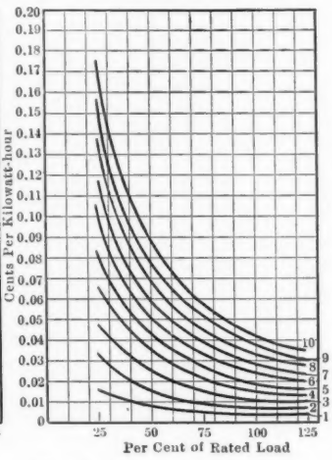


Fig. 4. Producer Standby Loss

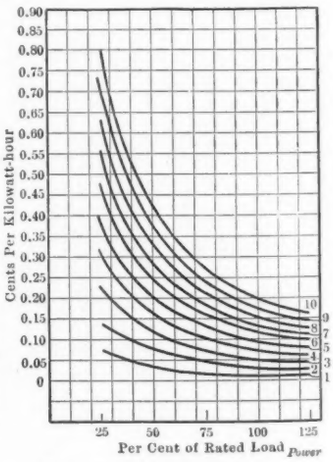


Fig. 5. Steam Auxiliaries and Standby

*Abstract of a paper read at the St. Louis Convention of the National Electric Light Association, May 25, 1910.

chandise alone, through smoke, amounts to more than $50,000,000 per annum, and the smoke permeation of the atmosphere costs the citizens of Chicago more than $75,000 a day for extra lighting. A concrete example of the damage done by smoke is the fact that each year over $1000 is spent in cleaning the exterior of the Majestic building, which is only one of a hundred or more so cleaned.

The damage which smoke inflicts can hardly be estimated in money. It is equally impossible to estimate the amount of suffering, disease and destruction, and the general effect of lowered vitality upon the people, caused by this nuisance. A careful inquiry was recently made by the United States Government concerning this nuisance. Unfortunately, but few cities have investigated the costs involved. Summing up the conditions in a number of cities, the estimate is made by the authority that smoke costs the American people more than $500,000,000 each year in the destruction of merchandise, the defacement of buildings, tarnishing of metals, injury to human and plant life, the greatly increased labor and cost of housekeeping, and the losses to manufacturers due to the imperfect combustion of coal. This loss of $500,000,000 is principally suffered by the 30,000,000 people who live in the large and middle-size cities of the country. The Cleveland Chamber of Commerce estimates that smoke costs that city alone $4,000,000 a year.

It is not maintained that the correction of the foregoing evil is exclusively the function of the internal-combustion engine. Many smokeless plants are operated in connection with both steam engines and turbines. But it is undeniably a fact that smokeless combustion is an element of gas operation and that it is most efficiently and simply obtained through such a medium. It is also true that a large number, possibly the majority, of the so called "smokeless" steam-engine operations are obtained at a material expense of fuel, due either to a high degree of air excess in combustion or to the use of steam, either directly used, in combustion, thereby increasing the weight of the effluent product, or, secondarily, through mechanical devices, expensive both in the operation and maintenance.

The lack of steam for heating has been one of the principal arguments against the general adoption of the gas-engine prime mover. Upon this basis, however, there is little doubt that a gas-power plant with live steam used for heating, would in many instances be more economical (taking into consideration the complete cycle of twelve months) than a steam-power plant utilizing the exhaust steam. However, the steps recently taken toward the recuperation of the waste heat from the gas engine are making the gas-power plant at least independent in the generation of its own heat. In this connection it may be of interest to point out that recent practice shows a duty of about two pounds of steam equivalent evaporation at 212 degrees Fahrenheit, generated by the sensible heat of the exhaust gas per brake horsepower-hour, or, roughly speaking, per pound of producer fuel fired.

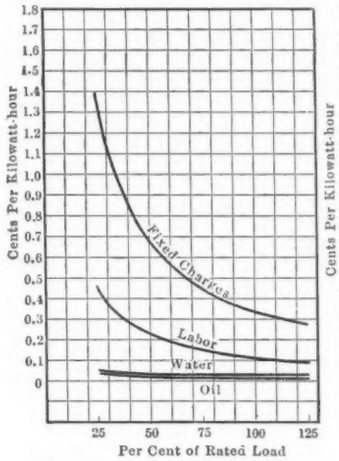


FIG. 6. STEAM PLANT FIXED CHARGES, ETC.

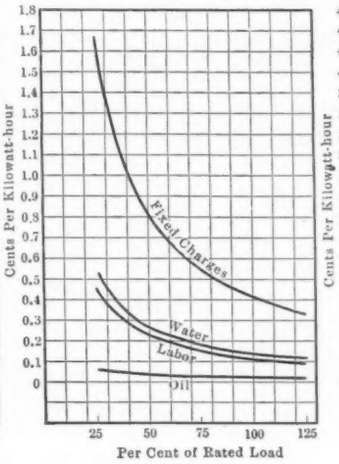


FIG. 7. GAS PLANT FIXED CHARGES, ETC.

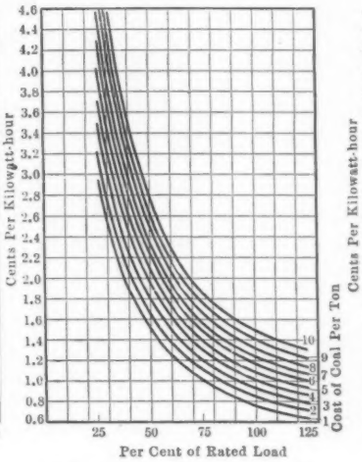


FIG. 8. GAS POWER TOTAL COSTS

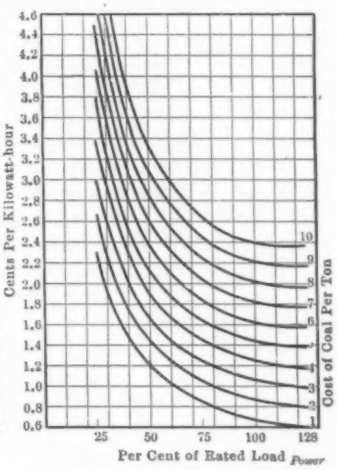


FIG. 9. STEAM POWER TOTAL COSTS

ECONOMICS

The actual fuel economy *per se* shown by the internal-combustion engine over either the reciprocating steam engine or the turbine must be generally admitted. Although there may be instances of exceptional fuel economy, due to peculiar conditions of load or extraordinary circumstances, generally speaking, a gas engine may be said to halve the fuel bill. The following figures approximate very closely the relative thermal efficiencies of these prime movers:

Gas engine (75 per cent. load factor)	25 per cent.
Triple-expansion (pumping) steam engine, full load	15 per cent.
Steam turbine	13.5 per cent.
Compound condensing engine	13.5 per cent.
Compound engine noncondensing	8 per cent.
Simple Corliss noncondensing	6.1 per cent.

It has been claimed that the lower efficiency of the gas engine at low load prevents its lending itself with a high degree of economy to central-station work. This, however, is not as serious as is usually maintained. Fig. 1 shows a comparison of the average efficiencies of these prime movers at various loads.

In the case of street-car service, for instance, there is probably the most drastic demand of any form of industrial service, and while it is difficult to take care of momentary variations, it is possible, by a proper regulation of the engines, and a careful study of the load, to adapt the engines very closely to the demand curve. For instance, during any periods of low loads, one, two or three cylinders may be cut out of service and the remaining cylinder or cylinders operated under full compression and regular mixture, at a high efficiency; the one stand-off to such operation is the friction load of the dead cylinders, which is not materially great.

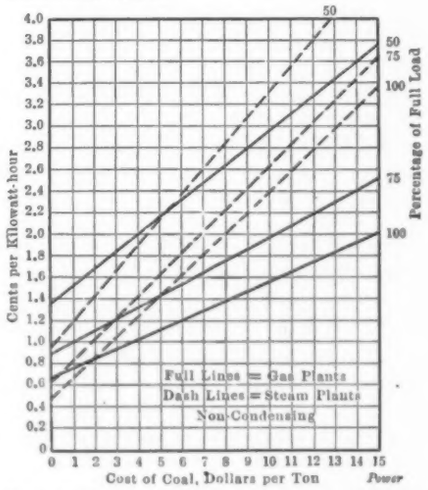


FIG. 10. COMPARISON OF GAS- AND STEAM-POWER COSTS

The major element in the economics of central-station work of today consists in the adaptation of installation to load factor, and the net profits accruing from the operation of such a station depend on the proportion of mean load to peak. As a corollary we come to the "bogy" of all operations, "readiness-to-serve." In

one plant with which the writer is acquainted, a thunder shower, with its attendant clouds, may within seven minutes throw upon the switchboard a sudden peak of 40,000 kilowatts due to lighting demand. The question now arises as to the most efficacious manner of handling a "readiness-to-serve" proposition of this kind. Evidently, under conditions of normal operation, it is necessary to maintain in such a station apparatus of from 40,000 to 50,000 kilowatts capacity in continual readiness for an almost instantaneous demand. The standby cost of maintaining boilers at steam pressure under such circumstances is high, and there is also the strain upon the boilers themselves, their depreciation and maintenance. The standby cost of gas producers under similar conditions is probably not more than one-tenth this fuel cost, while the incidental depreciation and maintenance would be negligible. Moreover, with a reasonably small supply of gas in a storage holder, it would be possible to start the engines and maintain them in operation upon the reserve gas until the producers have been made active from a condition of banked fires. Under such an arrangement a gas engine may be comfortably started in from one to two minutes: an infinitesimal time, as compared with a steam prime mover.

In considering the difference between the cost of a steam plant and that of a gas plant it is common practice to add the full fixed charges on the difference in investment to the operating expenses, and to deduct only the difference in fuel consumption. This does not give a logical or equitable comparison. The fairer way would be to capitalize the saving in operating expense proper. For example, if the difference in operating expense, exclusive of fixed charges, is $5000 per annum in favor of the gas plant, then the first cost of the plant should be credited with $5000 at the end of the first year, interest on this $5000, together with another $5000, at the end of the second year, and so on.

Comparative Operating Costs

The charts, Figs. 2 to 10 inclusive, show the comparative operating costs of a gas-power plant of 1000 kilowatts capacity, using a bituminous gas producer of 65 per cent. efficiency, and a steam plant of equal capacity, comprising water-tube boilers and compound noncondensing Corliss-type engines. The coal used in both plants is assumed to have a heat value of 13,000 B.t.u. per pound; the curves show costs with coal at prices ranging from $1 to $10 per ton of 2000 pounds. The standby loss for the gas plant is put at 5 per cent. of what the coal consumption would be running always at full load; that for the steam plant is put at 12 per cent. of the full-load rate. The plants are supposed to operate 12 hours per day, every day.

The labor charge for both plants is assumed to be $1.15 per hour, for a chief engineer, an oiler, a fireman and a helper.

The gas-engine cylinder-oil consumption is assumed at 9 gallons per day at all loads and is figured at 35 cents per gallon; 25 per cent. is added to cover cost of waste, grease, and replenishing a gravity-oiling system. The oil consumption of the steam engine is assumed at 4½ gallons per 24 hours at all loads and is figured at 35 cents per gallon; 50 per cent. is added to cover the cost of waste, grease and replenishing a gravity-oiling system.

The cost of gas-plant water is based on a consumption of 10 gallons per brake horsepower-hour for cooling the engine and 5½ gallons for the producer. It is assumed that the total consumption is constant at all loads and that this water is not recovered. The water is figured at 6 cents per 1000 gallons. The cost of water for the steam plant is based on the consumption by the main units of 20.7 pounds of steam per brake horsepower-hour and a generator efficiency of 93 per cent.

CORRESPONDENCE

Measuring Indicator Diagram Areas

In a recent issue of Power there was published an account of an area measurer for irregular figures such as indicator diagrams, consisting of small magnetized steel balls, which were used to cover the figure and then placed in a measuring frame to determine the rectangular dimensions equal to the irregular figure.

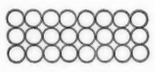


Fig. 1.

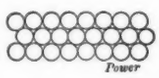


Fig. 2

This device is evidently regarded as something new, and is undoubtedly original with the present inventor, but owing to the fact that the trick of finding the area of indicator diagrams by means of small bird shot has been of common knowledge amongst marine engineers for at least fifteen years and probably much longer, there seems to be little chance of obtaining a patent. The idea of using magnetized steel balls is, of course, quite ingenious and an improvement over the old method, but I fail to see any necessity for the vernier used in connection with the measuring frame, as the only measurement required is the number of rows of balls, because for accurate results the balls must occupy the same relative position in the measuring frame as when on the diagram, not like Fig. 1 in one case and Fig. 2 the other. The old method employed no measuring frame, far more accurate results being obtained by multiplying the number of shot required to cover the diagram by the squared diameter of one shot, which latter figure only had to be obtained once and thereafter used as a "constant" to be multiplied by the number of balls. Another scheme was

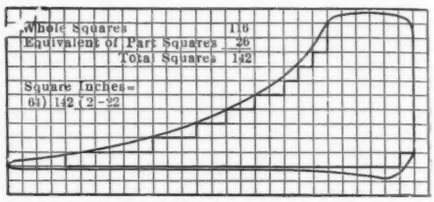


Fig. 3.

to take the diagrams on "quadrille" paper ruled into ⅛-inch squares. The full squares were counted first, and the half and quarter squares along the edges added later. The number of squares divided by 64 gave the square inches in the diagram (see Fig. 3).

R. H. Fenkhausen.

San Francisco, Cal.

Steam heat for snow removal around switch points has been successfully employed, according to the *Railway Age Gazette*, in the Erie station at Jersey City. The installation covers 26 sets of points and has been in service for three years. A 2-inch main is led from the power house in the adjoining yard, and a 1-inch lateral to each switch. Two lines of pipe, forming a loop, are placed between switch ties under the points, the ballast first being removed. Automatic traps take care of the condensation, and thus prevent freezing. The snow melts as it falls and no attention to the points is required. Throughout the severe winter of 1909-10 no difficulty was experienced and a small force kept the pipe lines and detector bars clean.

The packing of condenser tubes is a somewhat tedious process, whether it be accomplished with wooden ferrules or by the more common process of plaited cotton wound into the recess in the tube plate by means of a special tool. According to the *Marine Engineer and Naval Architect*, some rows of condenser tubes packed experimentally with rings of fiber appear to have given satisfactory results with a considerable saving in time. These rings are made to suit the depth of the recess in the condenser tube—about half-inch—and to slip easily over the tube. The outside diameter being somewhat less than the screwed part of the recess, the water swells the fiber and gives a perfectly tight packing.

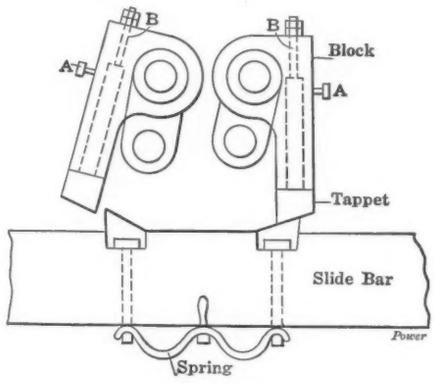
Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Adjusting Tappets on Valve Gear

While visiting a certain engine room I discovered a rather ingenious kink in the arrangement of a valve gear on an old type of Green engine. As is well understood by engineers who have had experience with this type of engine, the valve gear is composed of two rock shafts connecting with flat gridiron valves in the steam chest, located at the top of the cylinder. On the outer, or the valve-gear, end of these rock shafts are tappet blocks engaging toes on the slide bar, which in turn derives its motion from the steam eccentric, the governor operating in conjunction with flat springs under each toe and thereby raising or lowering these toes for engagement with the tappets as the conditions of load demand.

In this style of gear the tappets are not at all adjustable, and on the return stroke merely come in contact with the back of the toe. The latter is beveled



MEANS OF ADJUSTING TAPPETS

and when raised up the tappet slides over it and drops on the front side. It is then ready to engage again and open the valve. In order to prevent these upper tappets from falling out of the block a slot is cut in the shank of the tappet and a screw, *A* inserted in the block, thereby allowing the tappet to drop but a certain distance, the regulation being effected by the action of the governor on the lower toes.

When this type of valve gear was new it worked satisfactorily, but after a time, owing to the continuous dropping of the tappet on this screw, it naturally became worn and allowed the tappets to drop lower and increase the catch on the lower toes. As no two pieces wear alike, the load on each end of the cylinder gradually became very unequal. The usual method of correcting this inequality was to file the slot in the tappet, measuring with a scale till each side had the same amount of drop. This was all right when the engine was standing still and the lower toes were forced up to their highest capacity by the flat springs, but when the engine was up to speed and the action of the governor had forced the toes down the desired distance to accommodate the load, these flat springs in many cases became uneven owing to difference in tension, thus changing the catch of the tappets and bringing on the same condition as before the slots were filed.

In order to meet this condition of affairs the engineer discarded the screws in the blocks and drilled and tapped a ⅜-inch hole in the top of the shank of each tappet, into which he inserted ⅜-inch rods with long threads, shown at *B* in the illustration. This rod extended up through a hole in the top bonnet of the block and carried a nut and locknut, by which it was possible at any time to lower or raise the tappet, thus giving absolute control to suit any condition.

CHARLES H. TAYLOR.

Bridgeport, Conn.

Friction in Pipe Bends

The accompanying set of curves show the friction loss in pipe bends in terms of head of water. They should prove useful to the designer, especially in estimating the power required of a pump in delivering water through tortuous pipe lines.

Curve No. 1 shows the head in feet of water corresponding to any velocity in feet per second, not including friction; and is plotted from the well known formula,

$$H = V^2 \div 2g.$$

Curve No. 2 shows the loss due to a right-angle bend with a radius equal to the inside diameter of the pipe as shown at *A*, Fig. 2. These values are plotted from the formula

$$H = 0.6\ V^2 \div 2g,$$

the coefficient 0.6 having been obtained from experimental data.

Curve No. 3 represents the loss in a right-angle bend of a radius equal to three times the inside diameter of the pipe as shown at *B*, Fig. 2. The formula used in plotting this curve is,

$$H = 0.2\ V^2 \div 2g.$$

If a sharp bend, such as shown at *C*,

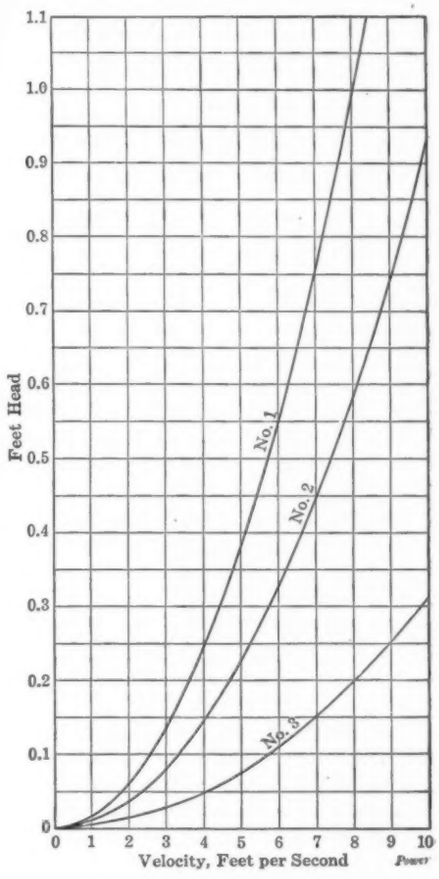


FIG. 1. FRICTION CURVES

Fig. 2, is used, the friction-head loss will be

$$0.98\ V^2 \div 2g.$$

This gives a curve which follows so closely the contour of No. 1 that it has been omitted in the diagram, for the sake of clearness.

To use the curves, first find the head

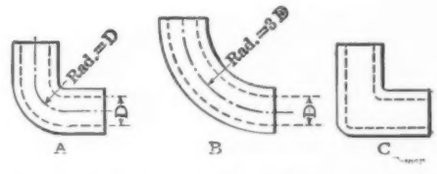


FIG. 2. BENDS TO WHICH CURVES APPLY

corresponding to the given velocity from curve No. 1, then find the friction head due to each bend in your line and add the results to obtain the total head.

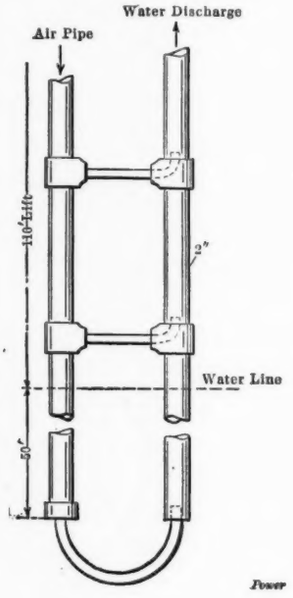
W. V. TREEBY.

Ilford, Eng.

Information Desired on Air Lift

Being interested in the subject of air lifts, I am submitting the accompanying sketch which represents the arrangement of piping used by one of the large Western railroads. I have never seen this used, but have had a description of it from another engineer who vouches for its authenticity.

Will some readers of POWER who have



AIR LIFT

seen this system of air lift in operation, kindly answer the following questions: How far apart should the branches be placed? What diameter should the branches be with air pressure at 50 pounds gage, a 2-inch discharge pipe, 50-foot submersion and the water to be raised 110 feet?

WILLIAM BEATON.

Gold Roads, Ariz.

Equalizing Lead and Cutoff

In order to equalize the work on the two sides of the piston, it is necessary to have the cutoff occur at the same point on both strokes. This can be done very easily on a slow-speed engine, where the lead is of small importance, but where engines are designed to run at a high speed it is very essential that they have enough lead to fill the clearance with steam at, or near, boiler pressure before the beginning of the stroke. On the other hand, with too much lead the mean effective pressure would be materially decreased because of the increased back pressure. From this, we see that lead is essential in high-speed engines; and in an effort to balance the work, many attempts have been made to equalize both lead and cutoff on each stroke. This condition, however, has never been satisfactorily attained, in a slide-valve engine, because of the fact that the piston travels faster when approaching and receding from the head end than it does in a similar position at the crank end, due to the angularity of the connecting rod.

One method which partly accomplishes the desired result is the displaced rocker arm, which is used by the General Electric Company on its marine engines, in connection with an indirect valve.

This rocker arm is direct in action, but has an angular displacement between the two arms as shown in Fig. 1. The result of this angularity can be seen by referring to Fig. 2; $O\,B$ represents the position of the lower arm when the valve is in mid-position, and $O\,E$ the position of the upper arm at the same time; the chord $A\,C$ represents the total travel of the valve, while $D\,F$ is the total travel of the upper arm. The circle $M\,P\,N\,Q$ represents the path traveled by the eccentric.

While the eccentric moves from M to P, the valve travels from its mid-position to its highest point, that is, to its maximum port opening on the head end and again reaches mid-position when the eccentric gets to N. While the eccentric is traveling to Q and back to M, the valve travels to maximum port opening on the crank end and back to mid-position. Since the arc $M\,P\,N$ is less than the arc $M\,Q\,N$ it is evident that the valve travels faster during admission on head end than it does during the same event on the crank end. As this occurs at the same time the

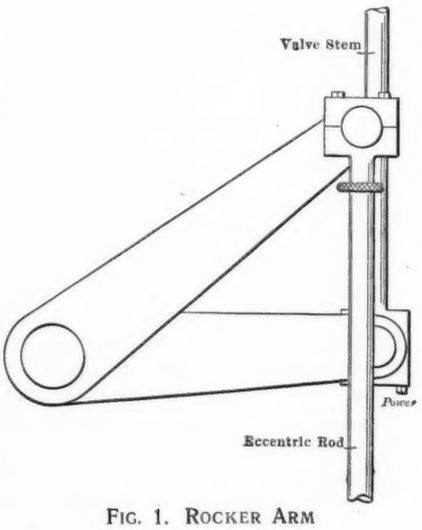


FIG. 1. ROCKER ARM

piston is traveling at its maximum speed it might be assumed that the angularity of the rocker arm could be given such a value that the speed of the valve during admission on the two ends would be proportional to the speed of the piston at the same time. Such would be the case but for the fact that the same valve is controlling both admission and exhaust. And as we increase the speed to hasten cutoff on the head end we are at the same time hastening compression on the crank end. This limits the amount by which we can increase the speed of the

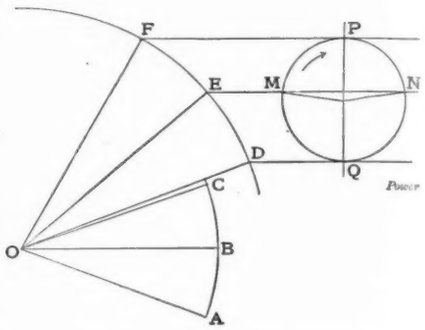


FIG. 2. MOTIONS DESCRIBED

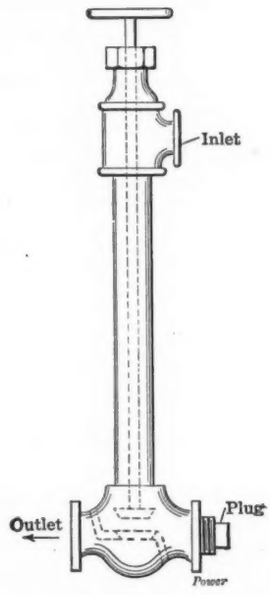
valve during head-end admission, and the problem is still only partially solved.

J. M. ROW.

Fortress Monroe, Va.

A Homemade Steam Trap

There was described to me a few days ago, a steam trap made of pipe fittings



STEAM TRAP

as shown in the accompanying sketch. The bottom consists of the body of a globe valve of any desired size into the top of which is screwed an iron pipe of from 2 to 3 feet in length. A malleable cast tee is screwed to the upper end of the pipe and into the top of the tee is screwed the upper part of the valve. The stem with seat attached is cut and is lengthened by the insertion of a piece of brass rod. This trap can be put together by anyone in a comparatively short time, and serves its purpose as well as a more expensive one.

J. E. NOBLE.

Toronto, Can.

Drop in Steam Pressure

Some time ago the writer tested a 300-horsepower Corliss engine. In working up the indicator diagrams we found that there was an average drop in pressure of 16 pounds from the point just above the the steam-inlet valve to the point at which the indicators were attached. This seems excessive in a distance of only about two feet. I have been unable to find very much on the subject and thought that perhaps some readers of POWER could enlighten me as to what a reasonable drop should be.

H. E. SATTERFIELD.

West Raleigh, N. C.

Packing for Pumps

The manner in which we pack our pump plungers may be of interest to some POWER readers. After trying all kinds and means of packing I finally hit upon the scheme of using a piece of rubber belting wide enough to admit of a washer being cut from it to fit into the chamber. I first caliper the suction chamber and then, with a washer cutter, cut enough washers to fill the space in the plunger. This material has proved to be the most satisfactory water-end packing that I have ever used.

A. F. LINDBERG.

San Luis, Cal.

An Accurate Method of Alining Shafting

On one occasion we had two 40-foot lengths of vertical shafting to install. We first attempted to aline this shafting by

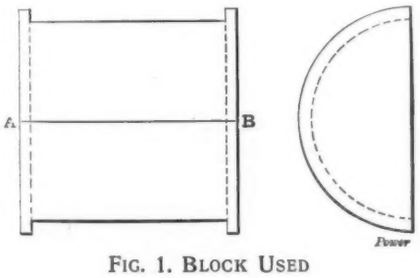


FIG. 1. BLOCK USED

the usual method of adjusting the boxes central to a plumb line by the use of calipers, but when the work was completed the motors refused to start on account of excessive friction due to inaccuracy in lining.

The method described below was next employed. Wooden blocks were turned to the shape shown in Fig. 1, and made to fit exactly into the back halves of the boxes. Lead-pencil lines *A B* were drawn through the centers of the faces of these blocks, representing the center line of the shaft. The top caps of the boxes were removed and the blocks fitted into the remaining halves of boxes. A plumb line was then dropped as shown in Fig. 2, and the boxes shifted until the lines on the blocks came in contact with the plumb line.

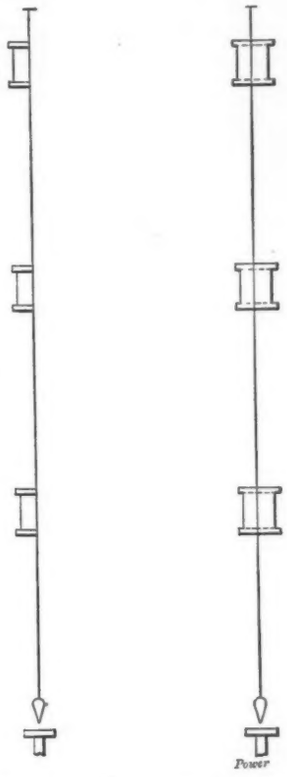


FIG. 2. METHOD OF ALINING

The shafting was again assembled and the motors started without difficulty.

G. J. REYNOLDS.

Anniston, Ala.

To install a new line of shafting or to add an extension to one already in service, requires experience and it should be done by a good millwright. While this may be expensive, it will pay in the long run.

However, if a millwright is not obtainable, the tools herein described will be found very convenient for alining shafting, and especially when an extension is to be added to another shaft.

Fig. 1 shows a gage used for alining bearings. It is made of heavy sheet tin to fit the lower half of the bearing, and

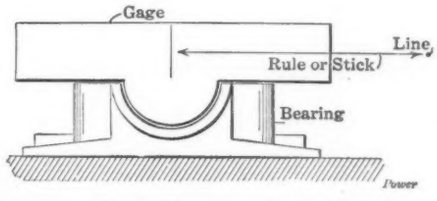


FIG. 1. GAGE USED TO ALINE BEARINGS

a stick or rule is used to measure from the center of the gage to the line. If this is done with all the remaining bearings they will be in line with each other. I have found this arrangement to make a better job than just gaging with a rule from the center of the box to the line, which in most cases is only guess work, as one cannot always strike the center of the bearing.

Fig. 2 shows a gage for alining the shaft after it is in the bearings, or for

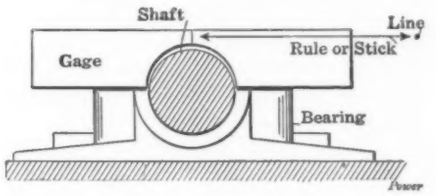


FIG. 2. GAGE USED TO ALINE SHAFTING

use on old shafting which may be out of alinement. The gage is placed over the shaft, then a measurement is taken as before from the center of the gage to the line.

H. A. JAHNKE.

Milwaukee, Wis.

Telephone Whistle Alarm

One thing that cannot be heard in the average power plant is the telephone bell and, as a result, engineers have designed various apparatus for signaling their telephone calls. The general arrangement is to have a bank of five 110-volt lamps in series, with perhaps a red light to distinguish them from other lamps that might be in the station, but even this is not effective.

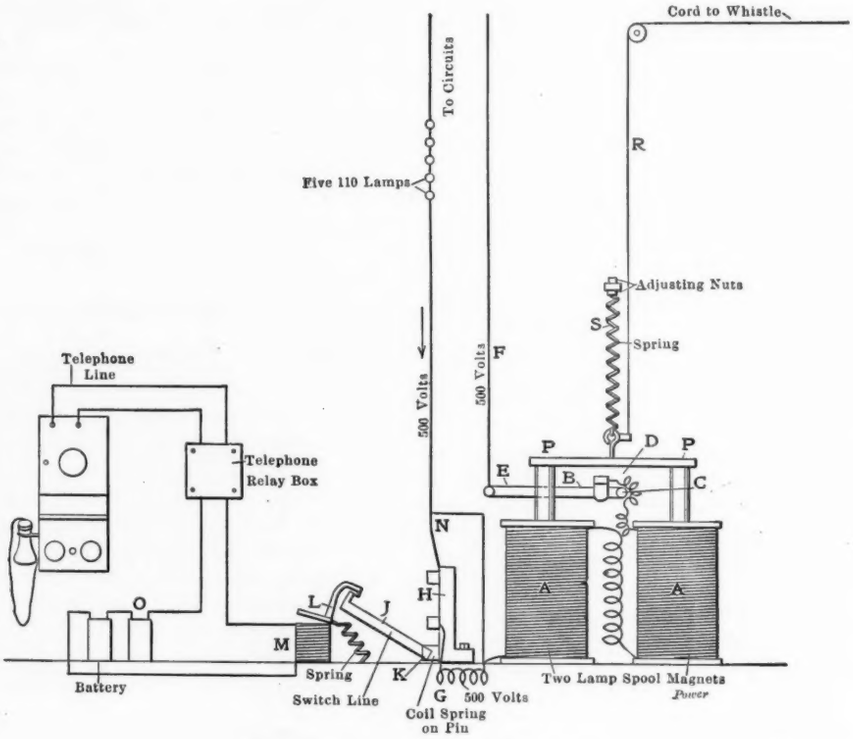
In the plant of the Charleston Street Railway and Power Company, Charleston, S. C., the chief engineer has arranged a whistle signal. Placed in a booth is a telephone of ordinary design, a telephone-relay box, a small magnet, which operates a switch automatically, two arc-lamp coils with their accompanying armature and a second switch. The general arrangement is shown in the accompanying illustration.

Above the lamp coils *A A* is a switch *B* which makes connection with a contact *D*. The blade of the switch has a pin at *C*, and is pivoted at the end *E*. A wire connection carrying 500 volts is attached to *E*. When the switch is in contact, as shown, the current passes out through the wire *F* from the switch *B* and coils *A A*.

Placed at a convenient point is a switch *H*, having two contact pieces, the knife blade *J* being pivoted at *K*, and held in an open position by the small catch arm and spring attached to the armature *L* of the magnet *M*. The lower terminal of the switch *H* is connected to the wire *G* while the upper terminal is connected to wire *N*. The current passing through the coil *M* is obtained from the batteries *O*, the wires from which also pass to the relay box.

The operation is as follows: When a telephone call rings in, current from the batteries passes through the magnet *M*,

which draws the armature *L* down and releases the catch from the end of the lever *J*, which is thrown into contact with the switch terminals by a coil spring placed on the pin at *K*. This sends a current of 500 volts through five 110-volt lamps, connected in series, and at the same time allows current to pass around the coils *A A*, which draws the armature of that set of coils down with a sudden movement and in so doing the handle *C* of the switch *B* is brought in contact with the armature *P*, which throws the switch out of contact with *D*. This breaks the circuit through *A A*, although the lamps still continue to burn.



WIRING OF WHISTLE ALARM SYSTEM

In its downward movement the armature *P* draws down the cord *R*, which is fastened to the lever of a whistle, and blows the whistle twice. This double blow is obtained from the amount of slack in the cord *R*, and the action of the spring *S*, which causes the armature *D* to return to its original position after being drawn downward by the current passing through the coils *A A*. When the call has been answered the switch *J* is thrown out of contact and held open by the arm *L*, and the switch *B* is thrown into contact and held in place by the friction of the contact piece.

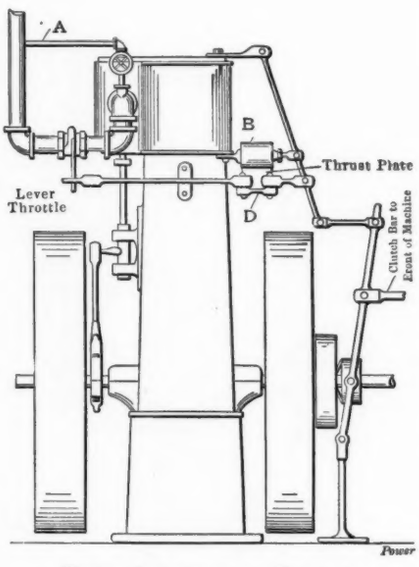
The effectiveness of this alarm was demonstrated while the engineer and the writer were out at the coal pile discussing the merits of various kinds of coal, the whistle alarm being distinctly heard above the noises of the plant.

R. O. WARREN.

New York City.

An Independent Drive

The following method of independent drive, I believe to be somewhat out of the ordinary, and for that reason it may prove interesting. The small upright engine shown in the accompanying illustration drives a cloth-printing machine, which during operation is frequently stopped. This caused some waste of time, and annoyed the printer to find the engine continually stopping on center.



DRIVE ATTACHED TO ENGINE

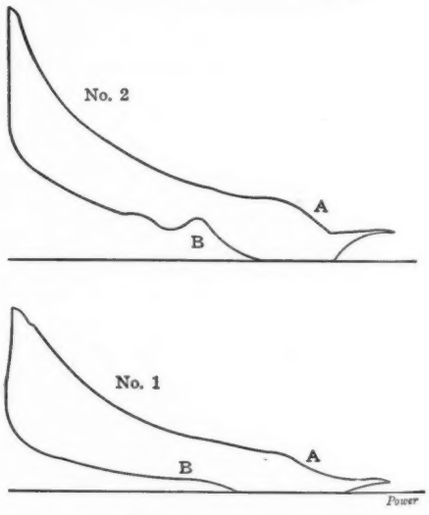
The engineer, being called upon for a remedy, decided to put a clutch between the engine and the machine, and to keep the former continually moving by bypassing the lever throttle valve with the small pipe *A*, the valve on which is open just enough to keep the engine at three-quarter speed when the clutch is open. To prevent too hasty opening of the throttle, the dashpot *B* was placed on the shifting levers. The plunger is fitted with a spring check valve which opens readily when it becomes necessary to stop the machine, but causes the oil to pass through a confined opening when the levers are moved to open the throttle and close the clutch, which is done at one operation. The link *D* converts one swinging movement into another, at right angles.

S. M. LESLIE.

Cambridge, Mass.

A Loose Indicator Spring

The accompanying diagrams were taken during a recent test on a Fay & Bowen two-cycle, two-cylinder, 10-horsepower gasolene engine. Anyone who is familiar with such diagrams can see at a glance that there was something wrong. The diagrams were taken with a Thompson out-side-spring indicator while the engine was running at 400 revolutions per minute.



DIAGRAMS TAKEN WITH LOOSE SPRING

The trouble proved to be in the indicator spring. The drop at *A* and the rise at *B* were due to the fact that the spring had become loose, caused by the vibration of the engine. Diagram No. 1 was taken when the spring was just beginning to loosen, while diagram No. 2 shows the maximum condition reached.

The point that I wish to bring out is this: An engineer who has been accustomed to take diagrams from a steam engine may be called upon to take diagrams from a gas engine, as described above. As the vibration of an internal-combustion engine is usually much greater than that of a steam engine, the indicator spring is more liable to become loose in the former case.

J. E. POCHÉ.

New Orleans, La.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Hot-water Meters

In looking over the issue of POWER for May 24, I noticed the article by N. L. Sammis on hot-water meters, which caused me to look up the article by Vassil Mackay in the issue of April 19, which escaped my notice.

I would like to say, in reply to Mr. Mackay, that in some forty years of experience in making tests in a professional capacity I frequently have used an all-brass, hot-water meter or meters. In setting them up I placed two gate valves at *D*, connected them with a T to the side outlet of which is placed a small valve which is always open when the meter is in service.

This arrangement insures that there is no leakage through the bypass valve or valves when the meter is in service, and comes in handy if a case ever comes into court and some lawyer tries to bother one, when he is giving testimony. I have been there and know.

If both of these correspondents will send me their full, post-office addresses, I will be pleased to tell them more about this question that will doubtlessly be interesting reading.

W. H. ODELL.

Yonkers, N. Y.

Pound in Engine

The letter by A. C. Waldron in the May 3 issue, on the causes of pounds in engines being misleading and hard to locate, reminds me of an experience that I once had in this line. Early one morning as I was engaged in adjusting the brushes of a dynamo on the opposite side of the room from the engine, I suddenly heard several loud heavy pounds which apparently came from the engine. I tore a large hole in the atmosphere in my rush to get to the throttle, my hair standing up like unto the tail of a fretful prairie dog. Just as I reached the throttle, the noise stopped and all that could be heard was the steady *hiss, hiss* of the dashpots of the old Corliss as she plodded steadily along in her efforts to chew up enough "No. 2 Northern" to fill 300 barrels with good flour within the next 24 hours.

As I stood with my hand on the throttle, my hair gradually resumed its normal position, and I had just about decided to go around and look over the bearings to see that they were all cool, when the pounding suddenly started again. I was now standing on the side of the engine room next to the mill, and near an open window. On looking out I beheld a big fat Dutchman busily engaged in banging a wooden pail against the side of the mill in his efforts to dislodge some ice that had formed in it, preparatory to filling it from a barrel into which the drains from the mill heaters discharged just outside the basement door.

I felt a burning desire to go out and make a large, deep dent in his anatomy with the toe of my shoe, but I noticed that he wore an expression of childlike innocence on his face, and decided that he had not done it with any malicious forethought, so I concluded to let the matter drop, swallowed my wrath, spit out a few "cuss words" and returned to my work on the dynamo.

The fact that in sizing him up I had noticed that there was an apparent difference of something like 300 pounds in our respective weights might possibly also have had something to do with my decision not to go out and kick him.

S. KIRLIN.

St. Paul, Minn.

The Engineer and the "Old Man"

In a recent issue of POWER a comparison was made between two engineers, one being dirty and slovenly, the other clean and uptodate. A comparison of this kind has two sides to it. A clean engineer is not always the best one. The "Old Man" is quite a factor. Like engineers, some desire their plants kept clean and uptodate, while others would not let the engineers keep them that way if they wanted to.

That the above is true, the following description of my experiences will show.

The plant was an average-sized, new paper mill. The first superintendent was one who desired his plant to be kept clean and uptodate. He never sent the engineers outside the engine room to do work foreign to their profession. Neither did he compel them to do their work according to his ideas, but just asked for results. We, the engineers, took particular pains in keeping the place in a respectable manner, and traveling salesmen, boiler inspectors and others declared that it was one of the cleanest and best-kept plants in the State.

In the course of time, another superintendent appeared. He was one who wanted everything done in accordance with his views, regardless of the work being important or insignificant. He would send an engineer to any part of the mill to do any kind of work. When we asked for material, such as mops, brooms, waste and polish, he would inform us that such things would not help to make paper and that we should dispense with them.

Within three months the place resembled one that had been in existence for many years, when, in fact, it had been built only three. By replacing the tubular boilers with some of a vertical, water-tube type, selected and installed in accordance with his plans, sufficient power was secured to operate the mill at full output. While erecting the boilers he decided to rebore a 24x48-inch Corliss engine and fit it with a new piston. When the new piston was put in, it was found that one packing ring overtraveled the port to the extent of one-half of the width of the ring.

When we informed the superintendent of this, and showed that the steam admission would have a tendency to collapse the ring at each stroke and eventually the ring would break, he said that he thought not, and in it went. A local machinist fitted the new piston and rod together and failed to get the piston up to the shoulder on the rod by a small amount. When told that it would become loose and only have to be taken out again, he could not see it that way, so it went in, along with the other misfit. In about six months' time the ring broke; a piece dropping into the exhaust port twisted the valve stem. In about three months more the piston came loose as predicted. A boiler tube began to leak near the top. The superintendent gave orders to run the boiler until the following Sunday. On suggesting that if the leak was in such a position as to direct the stream of hot water directly against a neighboring tube, that tube also might be injured, he said that he had never heard of such a thing and would risk it. During the following week the tube adjoining the one just taken out began to leak so badly that we were compelled to cut the boiler out.

On another occasion, when overhauling a stock pump equipped with brass ball valves, he had cast-iron seats made and left the sharp edges on them, saying that the valves would soon wear them off,

thereby making their own seats. When asked if he did not think it would also ruin the balls, he said he thought not. In about four months the pump refused to work and on taking it apart it was found that the valves had made their own seats as he predicted, but in shape the former valves compared very favorably to an overgrown goose egg. The result was a new set of valves. This is one of many cases in which the boss was to blame. Luckily such cases are in the minority. What is an engineer to do under such circumstances; only bide his time and look up another position? Unfortunately, other positions are not always forthcoming at a time when they would be most welcome.

JOSEPH STEWART.

Hamilton, O.

Ignorance among Engineers

I have often wondered why there are so few contributors to the columns of POWER from this side of the line and have thought that some of the readers might like to read a friendly criticism from a Canadian engineer of some of the engineering practices followed by our American cousins.

Two things I have noticed. The first is that a very large portion of the space in POWER is devoted to high-grade plants, their construction and operation. This, of course, is very interesting reading matter for all intelligent engineers, even though they have not the good fortune to have a place either in the construction or the operation of such plants.

The second thing, however, is not so creditable to our profession. It is the alarming ignorance of a large number of so called engineers in charge of plants who sometimes contribute to POWER. This ignorance, to my mind, is the cause, directly or indirectly, of many of the disastrous boiler explosions and other accidents which occur in steam plants all over the country. The wonder is that accidents are not more numerous than they are, when one reads of such conditions as plants are often found to be in.

That the States generally are legislating to better conditions is true, and it should be the aim of every intelligent engineer to have such legislation that will insure the safety of all employed around steam plants, even though it means the throwing out of work of many of the so called engineers.

I would like especially to mention what seems to be a common practice with many; namely, connecting water columns to boilers without intermediate valves both at the steam and water ends. This practice is not allowed in British Columbia.

There cannot possibly be established any certainty of a clear passage for both water and steam, by merely opening the drain from the water glass. This can be assured only by alternately closing the intermediate steam and water valves while the drain is open and seeing that both have a free course.

It is the bounden duty of every engineer in charge of boilers to make tests as often as is necessary, both with the water-column main connections and with the gage-glass cocks.

No rule can be laid down as to how frequently such tests should be made. This must depend on conditions. At one time, I had charge of a plant which was in continuous operation. The water was pumped from a swamp for use in the boilers, and it was necessary, to insure perfect safety, that tests be made at least once in every four hours, on account of the dirt in the water. In the plant that I now have, I am quite satisfied that all is well, if tests are made twice a week.

I enjoy reading the experiences of brother engineers. I am one among the thousands on this great continent who are up against all or some of the following conditions:

Worn-out engines, on poor foundations, forced to their utmost capacity.

Shortage of boiler capacity because of the class of fuel which has to be used.

Continuous addition of machinery to the plant, without the increase of power to operate it.

Such conditions call forth all of the intelligence and scheming capacity of the engineer in charge.

C. H. LEICESTER.

Nanaimo, B. C.

Engineers' Wages

Waldo Weaver, in the May 17 number, asks the readers of POWER to send in information concerning their wages, hours of labor and the nature of their work. Also, he asks them to state whether they get paid for overtime.

I am running a third-class plant in a school. We have three 54-inch by 16-foot return-tube boilers. They are used for heating and for running two small pumps.

The plant is started the first of September, and run until the last of May. During the months of September, April and May, I work eleven hours per day and get paid for overtime. Through the other six months a night man is put on. He has to work thirteen hours out of the twenty-four.

We each get $2 a day and the proprietors think that they are getting robbed when they have to pay that. They do not have to pay it to one man long, though, for the men do not stay.

E. GRANFIELD.

Boston, Mass.

The engineer in a small or average shop plant has to be on the job at least one hour before the other workmen, and remain one hour later. He has to clean out the boilers at least once a month. This means that he must work one Sunday every month.

If he is careless, reckless or intemperate his engines or boilers are liable to be destroyed, causing thousands of dollars worth of damage, and perhaps a great loss of life. If his firing is wrong, and he is wasteful in the use of packing and other material, his employers will be out of pocket.

The engineer has at least 1000 per cent. more responsibility than the average workman. If the ordinary workman is careless or intemperate, about the only person liable to get hurt is himself. He has very few chances of wasting or destroying material without the knowledge of the heads.

The engineer in many States and provinces has to study so that he can pass an examination for certificate. Besides this, he has to serve from two to seven years of apprenticeship. The engineer with a better technical education than the average mechanic gets far smaller wages.

To be chief in a large steam-electric plant an engineer must have had first-class practical experience. In addition, he must know something of chemistry, drafting, designing, erecting, etc. The managers of many factories draw from $5000 to $10,000 per year, and in most cases have no practical, and mighty little technical knowledge of the sciences enumerated above.

The chief engineer gets smaller pay but must have greater knowledge than the manager in most cases.

I cannot see how a license law will help to get better pay for the engineer. It is a good thing, however, as it compels him to study whether he will or no.

I suggest that all of the engineers in the country subscribe as much as possible and place a large sum of money in the hands of such papers as POWER or any other paper which has the welfare of engineers at heart. Let the publishers print interesting literature for manufacturers and employers of engineers all over the United States and Canada, telling them of the responsibility which the engineer has to assume; show them in print how a well paid, satisfied engineer can save them money (this last should interest them). Let the publishers do the mailing. Let them send copies to their advertisers, etc. Each association of engineers could also have a few thousand to mail to the small fry. I believe that some scheme of this sort would help the engineer more than all of the license laws ever enacted. I believe that I am right when I state that not 10 per cent. of the employers ever read a word about engineers and that they know but little of the engineers' duties or work.

Most advertisers look to see if their ad-

vertisement is O. K. in the advertising section but mighty few of them read the editorial pages, and tens of thousands of employers of engineers never even look at an engineers' paper at all. Therefore, I say, send them something gotten up attractively, which will cost them nothing but which will show them how they can save (in many cases) hundreds of dollars for the very few they will have to spend to get contented operators.

JAMES E. NOBLE.

Toronto, Canada.

Saving by Throttling Steam

The contribution on the above subject by H. P. Everette in the May 10 issue indicates, as the writer himself says, that his ideas on thermodynamics are somewhat hazy. Mr. Everette evidently has not grasped the true inwardness of adiabatic expansion, so the following may be of interest.

According to Thurston, the adiabatic-expansion line on a heat-energy diagram for a gas respresents the method of variation of pressures and volumes when no heat is communicated to, or emitted from the gas, all change of temperature of the gas being due to transformation of energy.

The expansion lines for steam, however, are somewhat different from those of a gas. If we start with initially dry, saturated steam, we would have to supply heat during expansion in order to keep the steam dry and saturated. But since by the definition of "adiabatic" no heat is supplied during expansion, the curve of expansion from an initially dry state to a final dry state is the "curve of saturation." During adiabatic expansion—such as occurs in a steam-engine cylinder—the steam gradually becomes a mixture of steam and water, the proportion of water increasing with progressing expansion.

If then we start with dry steam at 100 pounds absolute pressure and expand it to 80 pounds pressure, we will have a quantity of water at the termination of the expansion. The "quality" of the steam, or its percentage of dryness, dry steam being taken as unity, may be readily calculated, as indicated by John French in his communication. Thus, quality at 80 pounds equals

$$\frac{\textit{Entropy at } 100 \textit{ lb.} - \textit{entropy of water at } 80 \textit{ lb.}}{\textit{Entropy of vaporization at } 80 \textit{ lb.}}$$

"Entropy," as Mr. Everette doubtlessly knows, is the ratio of heat to absolute temperature: Thus entropy of steam at 100 pounds equals

$$\frac{\textit{Total heat}}{\textit{Absolute temperature}} = \frac{1186.3}{787.8}$$

Entropy of water at 80 pounds equals

$$\frac{\textit{Heat in water}}{\textit{Absolute temperature}} = \frac{282}{772}$$

Entropy of vaporization at 80 pounds equals

$$\frac{\textit{Latent heat}}{\textit{Absolute temperature}} = \frac{900.3}{772}$$

The values here given are taken from the Marks and Davis tables. The entropy values may be taken direct from entropy tables or curves, thus saving some calculation. These values give a quality of steam at 80 pounds of 0.9851.

The work done during adiabatic expansion may be calculated by the following formula:

$$\textit{Work in heat units} = H_1 - H_2 - 0.1852\,(p_1 v_1 - p_2 v_2)$$

H_1 = Total heat at initial pressure,
H_2 = Total heat at final pressure,
$p_1 v_1$ = Pressure and specific volume at initial pressure,
$p_2 v_2$ = Pressure and specific volume at final pressure.

The total heat H_2 is that found in steam tables multiplied by 0.9851, the quality of the steam.

Substituting in the formula, we have,

$$\textit{Work in B.t.u.} = 1186.3 - 1164.6 - 0.1852\,(100 \times 4.429 - 80 \times 5.47) = 20.72 \textit{ B.t.u.}$$

Multiplying by 778 we have,

$20.72 \times 778 = 16{,}120.16$ *foot-pounds.*

This is somewhat higher than Mr. French's result owing to the higher values of the total heats and specific volumes. Following Mr. French's procedure, we have,

$$\textit{Specific volume } 5.47 - \textit{specific volume } 4.429 = 1.041 \textit{ cubic feet.}$$

$$90 \times 144 \times 1.041 \textit{ cubic feet} = 13{,}491.36 \textit{ foot-pounds.}$$

This shows a difference of,

$16{,}120 - 13{,}491 = 2729$ *foot-pounds,*

as against Mr. French's,

$15{,}482 - 12{,}338 = 3144$ *foot-pounds.*

GEORGE W. MARTIN.

Brooklyn, N. Y.

Trouble with an Idler

I read with interest the article "Trouble with an Idler," in the April 26 number, by W. F. Cox. The arrangements in our plant, while similar to those described by Mr. Cox, seem to disprove his conclusion that the trouble was caused by too much wrap of the belt on the idler pulley.

For the same reasons as in his case, we also had to belt the generator back of the cylinder. We had, in addition, the disadvantage of an exceptionally short drive. While the distance between the centers of the flywheel and generator pulley should have been 31 or 32 feet, we could only get 21 feet 6 inches. This caused a small area of belt contact on the generator pulley and necessitated the use of an idler. Our flywheel is 8 feet in diameter, the generator pulley 19 inches and the idler pulley 30 inches in diameter. The belt is run very slack. The belt speed is 4750 feet per minute.

Mr. Cox says that he believes too much slack caused the trouble, but this statement disagrees with our results. He has about 40 inches from the top of the idler pulley to the top of the belt while we have only 3 inches and, consequently, considerably more wrap.

We have two units connected exactly alike and doing the same quantity of work. They work equally well on loads varying from 30 to 200 horsepower and we have no trouble from the belt creeping. Our idler frames face in the same direction as his do since he made the change.

W. C. THORNE.

Vineland, N. J.

Top Feed in Boilers

In reply to James Watt in the May 17 issue of POWER, I would like to know if he has ever tried the *steam-space spray feed* on boilers? If he has not, it might be well to try it some time as he might learn something that would be of great help to him.

L. EARLE BROWNE.

Roundup, Mont.

Installing Globe Valves

In the May 24 issue I noticed a discussion of Mr. Harris' suggestion to reverse stop valves so as to bring the pressure onto the top or back of the disk. I have met with many inconveniences from this cause.

I had been but one week in charge of a plant which contained two boilers, when one boiler was cut out of service for cleaning on Sunday. There were angle globe valves on the bottom blowoff pipes and the fireman complained continually about their being hard to open.

Sunday morning the valve was opened —apparently—to let the water out of the boiler. After about an hour it was discovered that the water had not lowered in the gage glass at all. An examination of the column and gage cocks showed that the glass was perfectly free from mud or scale. I then concluded that the blowoff pipe was clogged. I tried to blow back into this boiler by opening the blowoff valve on the other one. This had no effect. To get the water out of the boiler I disconnected the surface blowoff pipe just below the extension front and made a connection to the bottom of the water column. In this way most of the water was run out of the boiler. Then I removed the bonnet from the valve and allowed the remainder of the water to run out onto the floor. I saw at once that the valve had been put on "wrong side to" and the stem had broken off in the disk holder. The low pressure in this boiler on the larger area of the disk was more than a balance for the pressure from the other boiler on the small area under the disk. After I had put in a new stem and reversed the valve, allowing the pressure of the boiler to come on the under side, which aided the fireman very

much in opening the valve, we had no further trouble. In about a week the valve on the other boiler had the thread stripped off the stem and the boiler could not be blown down. The same operation had to be gone through to empty this boiler. Before it was placed in service again the valve was reversed.

While employed as assistant engineer in a large power station, I was ordered by the chief to remove the bonnet from a 4-inch angle valve on the steam pipe to one of the large condensers as soon as the load was light enough to stop both of the large engines, the small one exhausting to the atmosphere.

When the bonnet was removed, it was found that the bushing which held the valve stem to the disk had unscrewed and the disk had dropped down, leaving the valve useless. Had this valve been in with the steam pressure on top of the disk, it is safe to say that the street-railway as well as the day light and power service would have been suspended for some time before the exact cause of the trouble would have been discovered.

The loss of the vacuum would have necessitated 25 per cent. more power from the boilers, which would have lost more than half of their steam pressure in this case before more boilers could have been brought up to a working steam pressure.

On the boilers in my charge are 6-inch stop valves. The pressure in the boilers is underneath the disks and the pressure from the steam main is on the back of the disk when a boiler is out of service for cleaning. The disks kept breaking so frequently that I began to think that there was something unusually wrong. On entering the boiler room one morning, the boiler which had been cut out of service the night before showed 100 pounds pressure on the gage in place of 60 pounds as usual. The watchman said that the valve must leak as the pressure did not drop. He had put a wrench on the wheel and had turned it up tight but it would leak in spite of this. This watchman was a new man. It was his duty to cut in the boilers at night and to cut out any boiler which was to be repaired or cleaned. He had used an 18-inch monkey wrench and had screwed the valves up so tight that he had sprung the holders into a sort of cone shape. The disks, being forced back over this taper, would crack as fast as they were put on. As this repair was done on Sunday and no new holders could be obtained, I beveled one side of a disk to fit the bevel in the bent holder, by putting it into a chuck on a lathe although it could have been done with a file and scraper. This disk was in service for four months before it cracked, when a new holder and disk were put in. The holders were made of brass and therefore bent very easily, but the new ones, of large size, are made heavier and of iron.

Another plant of which I took charge while it was in operation had a globe valve on the discharge pipe from the feed pump close to the pump. There was no relief valve on the line. I noticed, as I was standing in front of the boiler, that the check valve did not click as usual; it seemed to have stopped very suddenly. I reached the pump in time to see the gasket blow out from the discharge chamber. The pump was stopped, the discharge valve closed and a new gasket put in. When starting the pump after opening the discharge valve the pump would hardly move. I opened the vent from the discharge chamber and found considerable pressure in the pump but had no gage to go by. I examined the valve as I was sure I had opened it for the discharge. It was leaking badly around the stem. Concluding that this valve must be stopped up, I shut the stop valve near the boiler and removed the bonnet of the valve under suspicion. The disk had broken off from the end of the stem and was held tight to the seat by the pressure from the pump. Had this valve been put in with the pressure from the pump under the disk the discovery of the broken stem would only have been made by accident as it would have acted exactly as a check valve and no harm would have been done.

R. A. CULTRA.

Boston, Mass.

Steam Liberating Surface

In response to the editorial request for information as to steam-disengaging surface, rate of evaporation, etc., of various boilers, I submit the following data from the electric-light plant of the town of Hudson. The plant contains three boilers of the horizontal tubular type, the diameters of which are 66 inches; the length is 18 feet. There are 72 tubes 3½ inches in diameter. The tubes are pitched with a wide space in the middle. Only two boilers are in service at one time. The water level in one boiler is carried about 19½ inches from the top, and in the other about 14½ inches. The steam-disengaging surface of the first boiler is equivalent to about 90 square feet, that of the second about 81 square feet.

Steam is taken off through an ordinary 6-inch pipe connection without dry pipe or other complications. The connections are made directly to the shell in the middle of the rear course. For feed water we use "city water" which is soft and contains very little scale-forming matter and nothing to cause foaming. The water evaporated per hour in each boiler is, during the day, 1580 pounds and during the night 1060 pounds. This makes an evaporation per hour per square foot of disengaging surface of 17.5 pounds for the day, and 13.1 pounds for the night run. The pounds of coal burned per square foot of grate surface per hour are 6.75 for the day run and 5.9 for the night run.

There is no way of telling anything about the quality of the steam delivered as no calorimeter tests have ever been made. The header is ample and well drained by steam traps. There are no separators on the lines to the engines.

WILLIAM E. DIXON.

Hudson, Mass.

Overtime Work

Recently, someone has asked the question, in POWER: "Should an engineer take his troubles home for solution after the day's work is done?"

Much depends upon the nature of the trouble and the state of mind of the engineer concerned. I certainly should want to lay everything aside unless my mind refused and, instead, on account of new features presented, compelled me to give a problem further thought.

Anything that will help one to do the work easier will naturally present this line of procedure. But when it comes to figuring up problems in a general way, where the principle, etc., is well understood, I believe it is entirely right and proper to cultivate the habit of dismissing such from the mind after coming off duty and letting it wait for further consideration until one goes on again.

A man may be employed by the day, month or year. It does not matter, he is entitled to a rest between shifts, unless by previous agreement, in emergencies, he works overtime.

LOYD V. BEETS.

Nashville, Tenn.

Jammed Piston Ring

In the May 17 issue of POWER I noticed George Russell's idea for getting the ring out of the steam port.

My conclusions are that Mr. Russell would not have accomplished the work by drilling a hole opposite to the port, for when he began to push the ring would it not have gone deeper into the port?

We can see what he was driving at, I believe, but it is evident that he did not get the "lay of the land" fixed in his mind right side up. The hole would have to be drilled down outside the port opening in the valve seat and intersect the opening into the cylinder bore before his plan would work.

After having read his plan, I see little reason why, if the port was not too long and crooked, etc., the difficulty could not have been overcome by procuring an iron rod and bending it somewhat to the curvature of the port and inserting it from the valve-seat opening and by that means lift the ring out.

L. VERNARD.

Nashville, Tenn.

Centralizing the Heat Supply*

By J. D. Hoffman

By assuming a hypothetical case, the writer follows through the various calculations necessary for determining the proper amount of radiating surface that may be supplied by the residual heat from any given plant.

The centralization of the heat supply for any district has an advantage over a number of smaller units in being able to burn the fuel more economically as well as being able to reduce labor costs. It has also the advantage, when in connection with any power plant, of saving a large amount of the heat that would otherwise go to waste in the exhaust steam and the stack gases.

If it becomes merely a question of burning the coal in the boiler and turning this heat at once into the heating system, there would not be so much advantage in centralization, because the loss in the conduit would probably counteract other small advantages gained in the plant. The price of the coal in such cases would be the controlling factor, because a much cheaper grade of coal may be used in the large plant than in the smaller ones.

Conduit Losses

The principal objection that is being urged against centralization is that it necessitates transmitting the heating medium through a system of conduits, which in many cases is a wasteful process. Improvements are continually going on to perfect the conduit work and to protect it from large heat losses, but as yet there is a large field for improvement. Concerning the losses from conduits no very satisfactory values may be given; everything depends upon the quality of the materials and the workmanship.

The writer believes, however, that the best installations should be able to keep the radiation losses below 10 per cent. but that many installations lose from 20 to 30 per cent. of the heat sent out from the power plant.

Exhaust versus Live Steam

To study the effect of exhaust steam upon heating problems and to determine, if possible, the theoretical amount of heat given off with the exhaust steam under various conditions, let us make several applications: First, to a simple high-speed noncondensing engine using saturated steam; second, to a compound Corliss noncondensing engine using saturated steam; third, to the first application using superheated steam instead of saturated steam.

Assume the following conditions: Case one—boiler pressure, 100 pounds gage; pressure at cylinder, 97 pounds gage; quality of steam at admission, 98 per cent.; steam consumption, 34 pounds per indicated horsepower-hour; 1 per cent. radiation loss in cylinder; and exhaust at 2 pounds gage. Case two—admission pressure, 122 pounds gage; quality of steam at admission, 98 per cent.; steam consumption, 22 pounds per indicated horsepower-hour; 2 per cent. radiation loss from cylinders and receiver; exhaust at 2 pounds gage. Case three—same as case one with steam at 150 degrees superheat.

Let r represent the heat of vaporization per pound of steam at the stated pressure, x the quality at cutoff, q the heat of the liquid per pound of steam, and W the number of pounds of steam per indicated horsepower-hour. From this the total B.t.u. entering the cylinder per horsepower-hour is $W\ (x\,r + q)$.

Case one—From Peabody's steam tables $r = 881$, $x = 0.98$ and $q = 307$. With $W = 34$, the initial B.t.u. will be

$$34\ (0.98 \times 881 + 307) = 39{,}792.92.$$

Deducting the heat radiated from the cylinder we have

$$39{,}792.92 \times 0.99 = 39{,}395\ B.t.u.$$

per horsepower, left to do the work. The B.t.u. absorbed in mechanical work per horsepower-hour is

$$33{,}000 \times 60 \div 778 = 2545.$$

Subtracting this from the initial heat we have 36,850 B.t.u. as the heat given up to the exhaust per horsepower-hour. Comparing this value with the total heat in the same weight of saturated steam at 2 pounds gage we have

$$\frac{100 \times 36\,850}{34 \times 1152.8} = 94\ per\ cent.$$

Case two—The factors in this case are: $r = 867.4$, $x = 0.98$, $q = 324.4$ and $W = 22$. Then the initial B.t.u. are

$$22\ (0.98 \times 867.4 + 324.4) = 25{,}837.9.$$

Less 2 per cent. radion loss, the above equals

$$25{,}837.9 \times 0.98 = 25{,}321.14\ B.t.u.$$

The heat absorbed in doing mechanical work is 2545 B.t.u. as before. Subtracting this we have

$$25{,}321.14 - 2545 = 22{,}776.14\ B.t.u.$$

as the heat given up to the exhaust per horsepower-hour. This is 90 per cent. of the heat which would be in the same weight of saturated steam at 2 pounds gage.

Case three—Computing this in a manner similar to the first two cases, we have the heat in the exhaust equal to 102 per cent. of that which would be in the same weight of saturated steam at 2 pounds pressure.

Owing to conditions not taken into consideration, the above percentages are probably higher than that which would be obtained in actual practice and it would be safer to place this value at 80 per cent. when calculating the amount of radiating surface to be supplied. Hence the available heat in a pound of exhaust steam may be taken as somewhere between 800 and 1000 B.t.u.

Amount of Radiation

Suppose, for example, that there is an electric-lighting and pumping station in the district, having available 23,100 pounds of exhaust steam per hour (maximum) from the generating units and 8680 pounds of exhaust steam from the city water-supply pumps. Also, that this amount be considered sufficient to justify a design of 184,500 square feet of hot-water radiation in the district. This amount of radiation should be allowed about 184,500 gallons of water per hour. With a pressure of 65 pounds per square inch on the outgoing line and 20 pounds on the return line, the direct-acting steam pumps will consume about 127.2 horsepower, which at 100 pounds of steam per horsepower-hour will give up 12,720 pounds of exhaust steam per hour. This when added to the exhaust steam from the engines and the city-supply pumps gives a maximum of 44,500 pounds of steam per hour to be used for heating the circulating water in the heating systems. Now since a pound of exhaust steam may be safely counted on to give up 800 B.t.u., as previously stated, and since each pound of water going through the plant is heated through a rise of about 30 degrees, one pound of exhaust steam will heat

$$800 \div (30 \times 8.33) = 3.2$$

gallons of water. Stated in other words, one pound of exhaust steam will supply 3.2 square feet of radiation in the district for one hour at zero temperature, and the 44,500 pounds of steam would supply 142,400 square feet.

As 184,500 square feet of radiating surface is required, and only 142,400 square feet can be supplied by the exhaust steam, we may supply part of the remainder with heat derived from an economizer in the stack.

From a previous statement, 44,500 pounds of steam per hour is generated in the boiler plant at a pressure of 125 pounds gage. To find the boiler horsepower, let the total heat in a pound of the steam at 125 pounds gage be 1191.8

*Abstract of a paper delivered before the National District Heating Association, at Toledo, O., June 1-3, 1910.

B.t.u. and the temperature of the incoming feed water 60 degrees. The heat put into a pound of steam is therefore,

$$1191.8 - 60 + 32 = 1163.8 \text{ } B.t.u.$$

and in 44,500 pounds it will be 51,789,100 B.t.u. Since one horsepower of boiler service is equivalent to

$$34.5 \times 969.7 = 33{,}455 \text{ } B.t.u.,$$

we will have

$$51{,}789{,}100 \div 33{,}455 = 1548$$

boiler horsepower. This horsepower will take care of all the engines and pumps in the plant. If the coal used contains 13,000 B.t.u. per pound, and the boilers have 60 per cent. efficiency, then

$$13{,}000 \times 0.60 = 7800 \text{ } B.t.u.$$

given to the water per pound of fuel burned.

The pounds of coal burned per hour will be

$$51{,}789{,}100 \div 7800 = 6640.$$

This means

$$6640 \div 1548 = 4.3$$

pounds of fuel per boiler horsepower-hour. It also means 6.7 pounds of water evaporated per pound of fuel. If the flue gases contain 12 per cent. CO_2, then there is being used about 21 pounds of air or 22 pounds of the gases of combustion per pound of fuel burned. This is equivalent to

$$6640 \times 22 = 146{,}080$$

pounds of flue gases, total. Suppose now that these gases leave the furnace at a temperature of 550 degrees Fahrenheit, that the economizer drops the temperature of the gases to 350 degrees, and that the specific heat of the gases is about 0.22, we then have

$$146{,}080 \times 0.22 \times (550 - 350) = 6{,}427{,}520 \text{ } B.t.u.,$$

given off from the gases in passing through the economizer. This heat is taken up by the circulating water. If the return water enters the economizer at 150 degrees and leaves at 180 degrees, we will have

$$6{,}427{,}520 \div (180 - 150) = 214{,}251$$

pounds of water heated per hour. This is equivalent to supplying

$$214{,}251 \div 8.33 = 25{,}720$$

square feet of radiation per hour when the plant is running at its peak load. Taking the "pounds of steam per hour" in the above as the only variable quantity we are fairly safe in saying that the heat in the chimney gases from one horsepower will supply, through an economizer, 16.5 square feet of radiation in the district. Hence, the 1548 boiler horsepower will supply 25,720 square feet of radiating surface.

This added to the 142,400 feet of radiating supplied by the exhaust steam makes a total of 168,120 square feet, and still leaves a remainder of 16,380 to be heated by some other source. This could be done by installing an additional boiler to be used as either a steaming or a heating boiler as the conditions demanded.

Kentucky N. A. S. E. State Convention

Those who once attend a convention of the Kentucky State association have such an enjoyable time that they never miss another meeting if it is possible to be present. Thus the convention grows in size and importance year by year. The eighth annual meeting at Hopkinsville, which occurred June 3 and 4, was the largest in the history of the State organization and was remarkable for the interest shown by the general public in the aims and purposes of the National Association of Stationary Engineers.

KENTUCKY ENGINEERS ASSEMBLED AT ENTRANCE TO CAMPBELL'S CAVE

Mayor Charles M. Meacham, of Hopkinsville, and Professor Brownell, who is an honorary member of the order, both complimented the delegates on the high principles which brought them together, to which J. N. Draper, State president, of Henderson, responded.

The most notable session of the convention took place at Odd Fellows' hall, with Col. W. A. Wilgus, of Hopkinsville, presiding. After opening with prayer by Deacon Ross Rogers, Fred W. Raven, national secretary, of Chicago, for the benefit of the business men and

citizens of Hopkinsville, gave a comprehensive idea of the objects of the National Association of Stationary Engineers and the benefits to an engineer of being a member. This benefit, it was shown, does not stop with the engineer himself, but extends to the community as a whole, in safeguarding the public and raising the standard of citizenship.

"The Utility of Technical Education, and How to Get It" was the subject of a thoughtfully prepared paper by Frederick L. Ray, State vice-president, of Louisville. The paper took up the subject with special reference to home study for the man who cannot leave his work to go to college, and made many suggestions as to methods whereby any engineer with the necessary ambition can acquire that which is so essential to success in life.

A high tribute to the engineer as a citizen was paid by Professor Hamlett, at this session, after which J. H. Meyer spoke in the interests of the supplymen.

A most interesting and mystifying exhibition of legerdemain, by J. L. Schrode, president of the local association, wound up the entertainment. This was pronounced by delegates and visitors as the equal of anything of the kind being given on the vaudeville stage.

At the close of the session the visitors had the opportunity of listening to one of the warmest heartfelt greetings ever extended to the association, by C. R. Clark, of Hopkinsville, making them feel that far-famed Kentucky hospitality was being extended to them in full measure, to make their visit a success.

Louisville was selected unanimously as the place of next meeting, the time for which will be the first Friday and Saturday in June, 1911.

Officers for the ensuing year were elected as follows: Frederick L. Ray, of Louisville No. 1, president; Asa Williams, of Owensboro No. 9, vice-president; J. L. Harpole, of Hopkinsville No. 10, secretary; J. H. Oelze, of Owensboro No. 9, treasurer; Calvin Carroll, of Louisville No. 1, conductor, and William Cummings, of Henderson No. 8, doorkeeper. Officers were installed by National Secretary Raven, assisted by O. Monnett, of Chicago.

When the work was finished the convention repaired in a body to Campbell's cave, a beautiful and historic spot near Hopkinsville, where an old-time Kentucky barbecue ended the festivities. Here, in the entrance to the cave, everything had been provided for the comfort of the visitors. From time to time, during the pleasant hours spent here, parties were made up with guides, to explore the recesses of the cave, which could be penetrated for a distance of 2 or 3 miles underground.

Taking everything into consideration it was the general opinion that Hopkinsville had set a record for hospitality which will stand as a model for subsequent meetings.

The firms having representatives at the convention were as follows:

V. D. Anderson Company, Cleveland, O.; Joseph H. Meyer.

James Clark, Jr., Electric Company, Louisville, Ky.; C. A. Ernst, C. L. Wheeler.

Crandall Packing Company, Palmyra, N. Y.; F. M. Wheeler.

Garlock Packing Company, Palmyra, N. Y.; William Hulvershorn, H. Simonds.

Gilbert Compound Company, Owensboro, Ky.; J. W. Gilbert.

Gunther Wright Machine Company, Owensboro, Ky.; S. A. Savage.

Indian Refining Company, Cincinnati, O.; Thomas Downer, Charles Viele.

Lunkenheimer Company, Cincinnati, O.; Joseph H. Hewetson.

Metcalf Mill Supply Company, Hopkinsville, Ky.; J. J. Metcalf.

W. H. Neil Company, Louisville, Ky.; C. L. V. Frank, F. J. Hofacker.

William Powell Company, Cincinnati, O.; W. H. Meenach.

POWER AND THE ENGINEER, New York; O. Monnett.

D. T. Williams Valve Company, Cincinnati, O.; H. J. Ernst.

Penn. N. A. S. E. State Convention

The eleventh annual convention of the Pennsylvania State association of the National Association of Stationary Engineers was held under the auspices of Pennsylvania association No. 16, of Scranton, on June 3 and 4. The meeting and exhibition rooms were in the assembly hall, located in the manufacturing building of the International Correspondence Schools, and were donated by the Schools.

The opening session was held Friday morning. Chairman E. J. Clarke called the convention to order. The address of welcome was made by Wallace G. Moser, secretary to the mayor, and replied to by National Treasurer Samuel B. Force. President Thomas J. Foster, of the International Correspondence Schools, then gave a talk, the subject of which was the benefits of a technical education for the engineer. State President John M. Lynch replied and then the business of the convention was taken up with the appointment of the various committees.

In the evening a banquet and entertainment was given at Liederkrantz hall. During the serving of the banquet the Amphion orchestra furnished music. J. D. Jones was toastmaster. Addresses were made by National President William J. Reynolds, Past National Presidents Joseph Carney and Charles H. Garlick, National Treasurer Samuel B. Forse, State President John M. Lynch, and Chairman E. J. Clarke. The entertainment was furnished by Messrs. Self, McKenna, Corbett, Murray, Armour and Frantzen of the New York "bunch."

President Reynolds in the course of his remarks said he looked forward to the time when it would be compulsory for the subordinate associations to become members of the State association.

At the Saturday morning session the delegates voted unanimously for a State license law and the following license committee was appointed: Chairman, George A. Bu Miller, 1712 Fulton street, Pittsburg, Penn.; John M. Lynch, of Erie, and E. J. Clarke, of Scranton. A paper on combustion was read at this session by E. A. Wilt, superintendent of power for the Scranton street railways.

On Saturday afternoon the delegates and guests were taken in trolleys to various points of interest in and around Scranton.

The following officers were elected: Past president, John M. Lynch, of Erie; president, Fred M. Zimmerman, of Pittsburg; vice-president, E. J. Clarke, of Scranton; treasurer, David E. Seeley, of Du Bois; secretary, Albert C. Cotton, of Pittsburg; doorkeeper, J. E. Livingston, of York; conductor, Norris D. Orms, of Johnstown. The next convention will be held at Johnstown, June, 1911.

The exhibits were held in a hall off the meeting room, which was tastefully decorated. The exhibitors were: Greene, Tweed & Co., *Practical Engineer*, Lagonda Manufacturing Company, W. B. McVicker Company, O. D. Havard Company, Trill Indicator Company, Lake Erie Boiler Compound Company, Quaker City Rubber Company, Ridgway Dynamo and Engine Company, E. Keeler Company, Valley Iron Works, Peerless Rubber Manufacturing Company, Lunkenheimer Company, Manning, Maxwell & Moore, Ashton Valve Company; McCan, Jr., Company, Garlock Packing Company, POWER AND THE ENGINEER, John T. Lindstrom's Machine Works, Cling-Surface Company, Jenkins Brothers, Wilhelm-Rivenburg Company, Ingersoll-Rand Company, Lackawanna Grate Bar Company, Strong, Carlisle & Hammond Company, Home Rubber Company, Charles B. Scott Company, Technical Supply Company, J. H. Williams & Co., Dearborn Drug and Chemical Works, International Correspondence Schools.

Institute of Operating Engineers

By J. C. Jurgensen

Its scope and purpose, as presented by the author before the Modern Science Club, of Brooklyn, N. Y.

Whatever may be one's view of the movement undertaken by the temporary organization of the Institute of Operating Engineers, no one can deny the fact that the men behind this movement have, within the last year, taken the question of advancement for the operating engineers' and the machinery operators' vocation out of the realm of ridicule, into which many have attempted to put it, and have secured for it the most serious attention of the best operating-engineering journals as well as many of the most prominent engineers and employers throughout the country.

It has been a noteworthy fact that power-plant men, with some notable exceptions, have been singularly careless in their estimate of the situation confronting the vocation, and have judged the movement solely in its aspects as it seemed to apply to their own individual condition and have therefore not looked upon the movement as one of a far reaching importance in its broad social and economic bearing upon the future value of the operating engineers' vocation.

Those men who do not see any immediate use to themselves of the Institute ideals and principles can be reminded that while it is the purpose of the Institute broadly to stand out for the elevation of the vocation as a whole, this can only be done by the aid of the individual member's enthusiastic willingness and eagerness to increase his own efficiency and self-respect as rapidly as opportunity offers. As willing members are assisted to advance and prosper, the vocation will advance and increase in prestige and value as an economic factor just as fast as the members of it realize their own individual duty and share of the work that must be done to win success for the vocation as a whole.

It is being generally admitted that the operating engineers' and the machinery operators' vocation does not get the general recognition that its possibilities as one of far reaching industrial importance really entitles it to receive, and when it is realized that it may be made a powerful agent for the conservation of both national and private resources, the vocation ought to be accorded the highest recognition from employers, the public in general and from every man in its own ranks, and not from a few only.

Remembering how living conditions and the daily comforts of every person are affected by our modern interwoven industrial life, which is so entirely based on the successful use of machinery and power, it cannot be called presumptuous to assert that every public-spirited citizen, in addition to those directly concerned, ought to be interested in having the objects and principles of this movement carried forward, since every person, whether employer or employed, is in one way or the other paying for inefficiency and uneconomic conditions allowed to exist in any part of the whole country's industrial organization.

Many operating engineers in all parts of the country, as judged by their letters of inquiry, are beginning to realize the position their vocation ought to occupy in the opinion of the industrial leaders of the country. These men see the duties that must be performed and they feel the burdens that are connected with the modern responsible master operating engineer's position; they can truly assert and prove from experience that the operating engineer and machinery operator belong to a class of men of whom it has been said that they cannot afford to make mistakes.

The man who operates a power plant, whether it is one of 5 horsepower or of 50,000 horsepower, certainly cannot make a mistake without endangering the lives of those who are depending on his intelligent and watchful care.

So much for actual danger due to mistakes, and just in passing it might be well to reflect on the enormity of the waste of energy and profits that is occasioned by careless and untrained methods of operating steam boilers and power machinery, unintelligent use of expensive fuel and in faulty handling of the subordinate plant worker. The true operating engineer has realized the cost of all these mistakes and it is a fact that a great number of plant owners have also realized the expense that is caused by an engineer who is one in name only.

It is time for us as operating engineers and machinery operators to understand the industrial importance of our vocation and to enhance its value by living up to the ideals and principles of the proposed Institute. We must make those most concerned see in our own actions how much is really dependent upon the conscientious ability and trained skill of the men who directly control the energy and operate the machines that supply the power and turn the wheels of all industry and commerce.

The operating engineers' vocation in spite of its great possibilities and responsibilities as a valuable industrial factor, is today in an extremely unsettled and unsatisfactory condition, honeycombed with weaknesses of which many are conscious.

It needs strong and vital ideals and principles to stand on and to gather about, for which every one of its members from the youngest junior apprentice to the master operating engineer can work and fight for, and in which any plant owner can heartily join because the motives and the methods are based on sound business propositions of mutual interest and value, for instance such as better working conditions where they are now bad, the getting and the making of better men, safer plants, cheaper power and consequently better remuneration for the men who have earned it. In other words, the Institute believes it is good principle and good business to insist that both parties involved in the business transaction of buying and selling labor and ability ought to give full pay for value received.

The vocation, because of internal weakness and lack of vital coöperation, is not regarded for what it might be, if it had clear and strong ideals that would bring into its councils men who would make membership in it something to be valued and considered an honor, for the enjoyment of which sacrifices could well be made by any man.

It is hoped and expected that the proposed Institute of Operating Engineers will attract men to its councils who are willing and able to analyze the causes of the apparent weakness and to bring up for orderly and systematic discussion the question of clearing away the obstacles in the way of seeing the real issue before our vocation, that of understanding and appreciating to the fullest extent the economic conditions and the individual attributes in the affairs of both employer and employee, which would make possible the same sort of relationship between the man who buys and the man who sells labor as generally obtains between the cultured and fair merchant and his equally cultured and broad-minded customer, that of mutual and sincere esteem for having returned full value for value received.

To further this purpose the Institute will endeavor to have its apprentices graduate as able and broad-minded journeymen machinery operators and to assist the best of its journeymen in becoming efficient operating engineers, a credit to themselves and an honor to the Institute. The Institute will try to serve the rank and file of the vocation and all those interested in its functions, and not only any one group of men or function in particular.

The essential principle of the Institute

is to facilitate and guarantee timely and intelligent training of apprentices and to induce Institute members of all grades to fit themselves for the privilege and the important duty of helping young men to become useful and efficient men.

The members who join now, as well as their officers to be chosen to guide the Institute, will be charged with the important duty of making the public as well as the prospective members realize that a membership certificate is to be considered a lasting mark of distinctive value to its possessor. They must so conduct the affairs of the Institute that apprenticeship certificates and diplomas of operating engineering awarded by it to worthy members must in all instances be regarded as a positive proof of ability and trustworthiness of character.

To succeed we need members of common sense, skill and tact, men who believe in the future of the vocation and are willing to apply the principles of consistent personal work among their own men and friends, and thus make the Institute of Operating Engineers a compact body of strong men who fully realize that we have arrived at a time where the life and the value of the vocation largely depend on the ability of all grades of its membership to stand solidly on its constitution and willingly to labor together on the principle that to realize and benefit by the possibilities of our vocation its dignity and prestige must not alone be upheld, but it is for each one of its individual members to prove its value beyond any doubt.

If the employer is not now as much interested in the welfare of our vocation as we think he ought to be, it can to a great extent be ascribed to the wrong ideas entertained by both sides of the mutuality and the relationship that exists between the employer and his men.

The proposed Institute sees this and is consequently organized with three main ideas in view, namely, apprenticeship for its apprentices, systematic education for all its men, and business cooperation between the man who buys and the man who sells labor and ability.

Furthermore it will do all to advance and elevate our vocation and give to it the semi-professional standing its inherent industrial importance entitles it to hold. These are purposes in the furtherance of which every operating engineer and machinery operator with vocational pride ought to labor and to strive for.

Every one of you gentlemen who wish our vocation to progress on its merits is invited to become a member of the Institute; sign your application blank and pay the entrance fee, and thus help make the Institute of Operating Engineers a vocational college, known throughout the world as a truly American educational, high-toned, scientific institution, guaranteeing its members and graduates to stand for merit, and whose influence will be felt as a factor for sound industrial progress and be an honor to its members.

Is the idea of the Institute a useful one to our vocation, and are we justified in pushing it? The answer to this question must eventually be answered by you as operating engineers, and the answer will determine the ultimate future of our vocation.

California N. A. S. E. State Convention

The seventh annual convention of the California State association of the National Association of Stationary Engineers was held at Los Angeles, during the week of May 23 to 28. It was in this city in June, 1894, that the association had its inception, starting with thirteen members; its remarkable growth is too well known to need repetition. The convention just closed proved the most successful of any State meeting heretofore held, and the visitors were entertained in a manner that left no doubt of the hospitality of southern California and its advantages for recreation. The delegates were welcomed to the city on the evening of the twenty-third, which also marked the opening of the first exclusive mechanical exhibit to be held in this city.

The diversions planned for the guests by the local branch were many. On May 25 they were taken over the "Ballon Route" to Hollywood, Santa Monica and Redondo, at which latter place they were escorted through the plant of the Pacific Light and Power Company, the 15,000-kilowatt station which holds a record for efficiency. Later in the week trips were made to Long Beach and to San Pedro, for an inspection of the harbor.

At the early meetings of the week interesting papers were read. At the Friday session the election of officers for the ensuing year resulted as follows: President, H. W. Noething, San Francisco; vice-president, David Brian, Los Angeles (chief engineer, Pacific Light and Power Company); secretary, W. T. W. Curl, Los Angeles; treasurer, Charles Knight, San Francisco; doorkeeper, Charles Comes, San Jose; conductor, L. E. Porter, Santa Barbara; trustees, J. H. Pyster, Santa Barbara; John Proper, Los Angeles; A. M. Dunn, Fresno. An important action was taken regarding State license laws for engineers and boiler inspection, and a committee was appointed to put the matter before the legislature.

The mechanical exhibit mentioned was open the entire week to the public and was encouragingly patronized. It was under the auspices of the local branch, who spared no expense or trouble in the enterprise. Ninety-nine booths displayed the products of representative concerns in the trade; leading among these were:

Axelson Machine Company, pumps.

Braun Chemical Company, industrial chemicals.

Byron-Jackson Iron Works, pumps.

Bowers Rubber Works, mechanical rubber goods.

Coffey Belting Company, belting.

Dearborn Drug and Chemical Works, water treatment.

De La Vergne Machine Company, refrigerating apparatus.

Fulton Engine Works, general machinery.

Fairbanks, Morse & Co., pumps and electrical machinery.

John Finn Metal Works, metals.

General Electric Company, electrical apparatus.

Harris Air Pump Company, air pumps.

Hammel Oil Burner Company, oil burners.

Herron, Rickard & CcCone, general machinery.

Hartford Steam Boiler Inspection Company, boiler insurance.

Johns-Manville Company, packing, insulation material, etc.

Jenkins Brothers, valves.

Kelman Electric Company, electric specialties.

Lunkenheimer Company, engineering specialties.

Liberty Manufacturing Company, tube cleaners.

Leahy Manufacturing Company, oil burners.

Los Angeles Rubber Company, mechanical rubber goods.

Maryland Casualty Company, boiler inspection and insurance.

Meese, Gottfried & Co., transmission machinery.

Pacific Clay Manufacturing Company, firebrick.

Standard Oil Company, oils.

Smith-Booth-Usher Company, general machinery and supplies.

Strait, H. N., Manufacturing Company, engines.

Union Well Supply Company, mill, mining and engineering supplies.

Western Electric Company, electrical supplies.

Western Gas Engine Company, gas engines.

Warren & Bailey, lubricating oils, packing, etc.

A banquet held at the Hamburger café on the evening of the twenty-eighth brought the convention to a close. A unique menu presented in mechanical terms was one of the features of the occasion.

Annual Convention Steam Engineers

The twenty-fourth annual convention of the American Order of Steam Engineers was held at Philadelphia during the week commencing June 6. The headquarters was at the Windsor hotel, and the various meetings of the convention were held at the Odd Fellows' temple. In a spacious hall in this building was also held an exhibition of power-plant apparatus and supplies, which attracted a good deal of attention.

On Tuesday afternoon there was a family gathering at Schuetzen park, and a happy time was spent. There was a baseball game between the engineers and supplymen, and, although the engineers won by the score of 11 to 3, the game was thoroughly interesting throughout. The prize was a handsome silver loving cup, donated by John R. Livezey. Frank Moore and G. F. Duemler were the umpires.

The trip up the Delaware river on Wednesday afternoon was thoroughly enjoyed, the city fire boats giving a special fire drill for the occasion. There was dancing and refreshments were served.

The feature of the program of entertainment was a vaudeville performance in the exhibition hall on Thursday evening, at which appeared Billy Murray, Frank Corbett and Jack Armour.

During the week there were many sight-seeing trips for the ladies.

The election of supreme officers resulted as follows: Frederick Markoe, chief; Lewis G. Schlehner, first engineer; Florian J. Armbruster, recording engineer; William S. Wetzler, corresponding engineer; Thomas J. Donovan, treasurer engineer; William J. Courtney, senior master mechanic; James Lightfoot, chaplin; D. B. Heilman, A. J. Diedrich, W. R. Smith, trustees; D. B. Heilman, chairman of educational committee.

It was unanimously voted to hold the next annual convention in Philadelphia, Penn.

At the meeting of the American Supplymens' Association on Thursday afternoon, the following officers were elected: President, Richard Foley, Home Rubber Company; vice-president, Harry Crowder, Crandall Packing Company; secretary, Fred L. Jahn, Watson & McDaniel Company; treasurer, John W. Armour, POWER AND THE ENGINEER.

The committee of Supreme Councils comprises George R. Richardson, Clifford P. Williams and Frank R. Moore.

The exhibition of power-plant supplies, held under the auspices of the American Supplymens' Association, was the largest ever held. Seventy-three concerns displayed their products. The general arrangement and decoration of the booths and hall were perfect in every detail, and the director of exhibits, Harry Souder, is to be congratulated.

Following is a list of the exhibitors: American Engineer and Manufacturing Company, *American Journal of Steam and Electrical Engineering,* American Steam Gauge and Valve Manufacturing Company, Anchor Packing Company, Ashton Valve Company, H. Belfield Company, Berry Engineering Company, Bird-Archer Company, Buffalo Mill Supply Company, Cyrus Borgner Company, Bundy Department, American Radiator Company, Cancos Manufacturing Company, Charles H. Casper, Central Construction and Supply Company, Clement Restein Company, Cling-Surface Company, Cortay Packing Company, Crandall Packing Company, Dearborn Drug and Chemical Works, Dexter Engineering Company, Diamond Power Specialty Company, Joseph Dixon Crucible Company, Dyna-Coma Company, Engineering Equipment Company, *Engineers' List,* N. B. Fails Lubricant Company, Fairbanks Company, France Packing Company, Garlock Packing Company, Greene, Tweed & Co., Harrison Safety Boiler Works, Home Rubber Company, E. F. Houghton & Co., Jenkins Brothers, H. W. Johns-Manville Company, Keystone Lubricating Company, Lagonda Manufacturing Company, John R. Livezey, George W. Lord Company, Lunkenheimer Company, McArdle & Cooney, McLeod & Henry Company, W. B. McVicker Company, Manning, Maxwell & Moore, James F. Marshall Company, Mason Coal Company, Nelson Valve Company, Parker Boiler Company, Peerless Rubber Manufacturing Company, Pennsylvania Flexible Metallic Tubing Company, Philadelphia Bourse, Philadelphia Council No. 7, A. O. S. E., Philadelphia Grease Company, POWER AND THE ENGINEER, *Power House, Practical Engineer,* Pringle Electrical Manufacturing Company, Quaker City Rubber Company, Roto Company, Albert Schade Company, Schoen-Jackson Company, Scully Steel and Iron Company, Skinner Engine Company, *Southern Engineer,* Stewart Heater Company, Strong, Carlisle & Hammond Company, Strong Machinery and Supply Company, Trill Indicator Company, Under-Feed Stoker Company of America, H. B. Underwood & Co., Vacuum Oil Company, Valvoline Oil Company, Vilter Manufacturing Company, Thomas C. Warley & Co., Watson & McDaniel Company, Warren Webster & Co., Welkirk Electric Company, J. H. Williams & Co., O. F. Zurn Company.

Coal Briquetting Plant in New York

With the increasing price of fuel the time has come when we must use up our leavings and practise small economies.

Abroad, such material is made into briquets, of which large quantities are used annually upon the railroads and for domestic purposes. Little has been done so far in this country notwithstanding the amount of accumulated and accumulating material available.

During our consideration of the reëxploitation of the Rhode Island Coal Mines (by the way they have never gotten around to that promised test between treated and untreated coal) we learned of a plant in New York City where some of the Rhode Island product had been briquetted. One of our editors visited the plant the other day and found it practically ready for the production of briquets upon a commercial scale. It is located at the foot of West Forty-eighth street and operated by the Economy Coal Company. The culm is received by water, and its handling and treatment after it leaves the storage bin is continuous and automatic. The process consists of drying, grinding, mixing in the binder while the coal is still hot, briquetting in a press which has a capacity of some twelve tons per hour, and baking to remove volatiles and odor. The result is a collection of briquets something under 2 inches square and an inch thick in the center rounding off to the edges, weighing about two ounces, so hard that they may be thrown against a brick wall without breaking, clean to handle and odorless. They retain their shape in the fire until entirely consumed, but crush to a fine ash upon being squeezed or struck. We saw them in use in the drying oven and under the boiler of the plant, and fires of briquets made both from Pennsylvania culm and from Rhode Island coal were kindled in stoves for our inspection. Both kindled easily, burned freely and with an intense heat. We were interested to learn that the process used was invented and patented by a lady, Miss Pauline Grayson.

It is intended to furnish the briquets in competition with anthracite coal, and a company is now being organized with offices at 225 Fifth avenue, for the purpose of operating this and other plants in Greater New York.

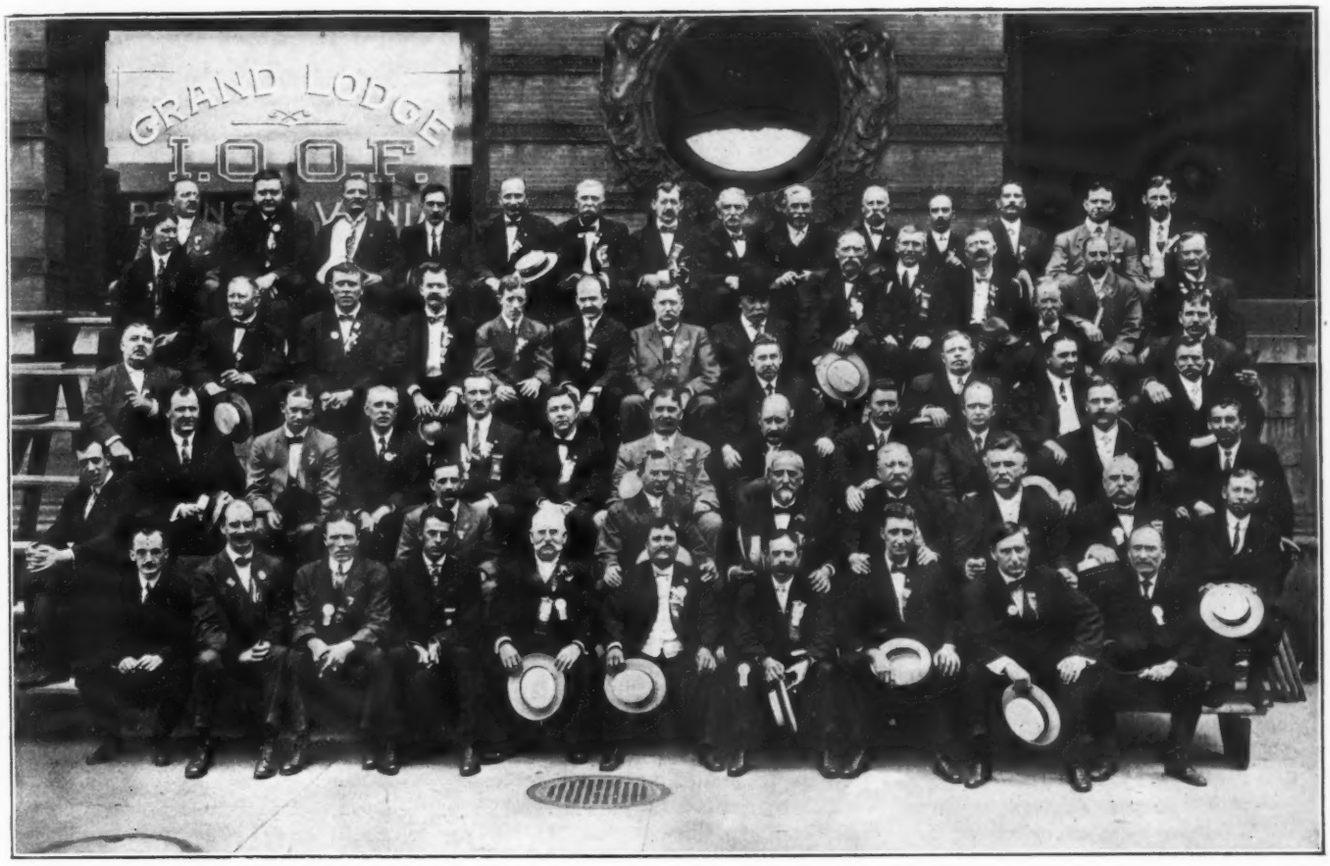


FIG. 1. A. O. S. E. DELEGATES AND OFFICERS ATTENDING PHILADELPHIA CONVENTION

FIG. 2. MEMBERS OF THE AMERICAN SUPPLYMEN'S ASSOCIATION ATTENDING THE CONVENTION

New York N. A. S. E. Convention

The fifteenth annual convention of the New York State association of the National Association of Stationary Engineers was held at Buffalo on Friday and Saturday, June 10 and 11, with headquarters at the Iroquois hotel, in which building were also the convention and exhibit halls.

The first business session of the convention was called to order by the chairman of the local committee, Winfield Graham, on Friday morning. After prayer was offered, Mr. Graham introduced John Sayles, secretary to the mayor of Buffalo, who made an address of welcome, State President Grover H. Woods responding. Edward A. Gilroy, a local member, spoke of the aims and object of the National Association of Stationary Engineers. Other addresses were made by National President William J. Reynolds, Past National President Herbert E. Stone, Edward J. Lee, chairman of the board of trustees of the *National Engineer*, and Past National President Patrick E. Leahy.

President Woods then took charge of the meeting and after the several necessary committees were appointed the convention adjourned.

There were two sessions on Saturday, at which much important work was accomplished. The several reports of the officers and committees were read and acted upon. The State organization is in a healthy condition and it is expected that many more of the local associations will have joined the ranks by this time next year. The new State license-law bill, compiled by the State license committee, was unanimously approved. The election of officers resulted as follows: Grover H. Woods, past president; Charles Schabacker, president; E. E. Pruyn, secretary; George O. Haley, treasurer; William Downes, conductor; F. J. Leopard, doorkeeper; John R. Coe, State deputy; Stewart Warner, chaplin. The next annual meeting will be held at Albany, N. Y.

On Friday afternoon there was an excursion on Lake Erie to Crystal beach, where a pleasant afternoon and evening were spent.

On Saturday afternoon the lady visitors enjoyed an automobile trip through the park system, under the guidance of the ladies' auxiliary.

The principal feature of entertainment was a banquet on Saturday evening in the Dutch room at Statlen's restaurant. Herbert E. Stone, who acted as toastmaster, told of the benefits derived by a membership in the National Association of Stationary Engineers, and paid a tribute to the ladies' auxiliary, presenting a beautiful bouquet of flowers to Mrs. J. N. Gregory, for her many courtesies to the ladies in attendance. John Sayles spoke in warm and flattering terms of the greatness and excellence of the city of Buffalo. E. E. Pruyn, in a fitting speech, presented a handsome clock to Past State President Grover H. Woods. Other brief addresses were made by W. J. Lee, Winfield Graham, W. J. Ranton and J. N. Gregory.

During the evening the assemblage was entertained by Billy Murray, of Jenkins Brothers, Frank Corbett, of Manning, Maxwell & Moore, and Jack Armour, of POWER. There were over two hundred seated at the tables. The accompanying cut shows some of the officials and men of prominence in New York State.

The exhibitors included the Liberty Manufacturing Company; Home Rubber Company; J. H. Williams & Co.; Buffalo Refining Company; Keystone Lubricating Company; Peerless Rubber Manufacturing Company; Farrar & Trefts; International Steam Pump Company; Robertson Cataract Company; Howard Brothers Boiler Works; Lake Erie Boiler Compound Company; Lunkenheimer Company; C. M. Stebbins Oil Company; Garlock Packing Company; POWER AND THE ENGINEER; Under-Feed Stoker Company of America; *Practical Engineer;* Greene, Tweed & Co.; Penberthy Injector Company; McCarthy Brothers and Ford; Dearborn Drug and Chemical Works; Manning, Maxwell & Moore; Albany Lubricating Company; Adam Cook's Sons; V. D. Anderson Company.

FLASHLIGHT OF THE MAIN TABLE AT THE BANQUET HELD IN THE IROQUOIS HOTEL, BUFFALO

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Power and The Engineer

Editorial

Consult the Engineer

Owners and architects sometimes make the mistake of installing important apparatus without getting the views of the man in charge of the plant, the one who will be responsible for the satisfactory operation of the machinery after it is put in place.

Every engineer has his own ideas about the arrangement of the various pieces of power apparatus and nearly always has carefully planned out the most efficient arrangement with respect to the particular plant with which he happens to be connected. This ideal arrangement is kept in mind and when changes are contemplated he is glad to go over with the owner his reason for installing things according to his ideas. It is reasonable to assume further that with the opportunities of observing the plant in everyday operation his council in these matters will be of especial value to the owners.

This was not recognized, however, by the management of a large institution in which extensive rebuilding of the power plant was taking place. Plans were drawn for the complete new plant without consulting the chief engineer. The coal was to be dumped from an alley and the space under the alley was to be used for coal storage. A battery of boilers was to be located opposite this coal-storage space, but in the plans they were turned around facing away from the bunkers, making it a laborious process to get the coal to the hoppers. With the boilers properly set, the conditions would have been ideal for a gravity feed direct to the stokers, minimizing the amount of labor and expense in the boiler room.

The engineer made frequent and vigorous protests against the layout presented in the drawings, but to no avail. As a consequence there is, and always will be during the life of the plant, an extra item of labor expense amounting to three thousand dollars per year for wheeling coal around the end of this battery of boilers from the bunkers to the stokers.

This increased cost of operation will in time easily amount to the entire first cost of the machinery installed and could have been saved by a little talk with the man on the job. The management saw the mistake after it was too late and when it was found that the overall economy of the new installation was not coming up to expectations.

Firms having engineers in whom they have no confidence should by all means let them go, and having obtained the right man, should consult him regarding any contemplated changes, thereby securing without cost the benefit of advice from the man most liable to know what is needed under the circumstances and best qualified to pass an opinion on the matter.

Chicago's Board of Examining Engineers

It has not been so long ago that a complete reorganization of the above body was undertaken by Mayor Busse, when, following charges of graft, the board management was placed in the department of the city engineer to be under the supervision of that official.

John Ericson, who was then city engineer, drew up a code by which the office was to be governed and which seemed fair to the operating engineers of the city. No sooner were matters apparently fixed up in satisfactory shape than something turned up to overthrow all the arrangements and leave things in worse shape than before. John Ericson, former city engineer, recently resigned from the board and is on a three months' leave of absence pending graft charges in connection with City Hall deals. It is also understood that another member of the former board has resigned and the affairs of the office have been delegated by the mayor to various officials in the water-service department. These officials have already all the duties which they are able to take care of and cannot give adequate attention to this department. Furthermore, they are expected to serve without additional compensation.

Under these conditions it is not surprising that the board has not of late been conducted to the satisfaction of the engineers of Chicago, and their action in appointing a joint committee from all the organized associations to see the mayor and protest against existing conditions is commendable.

The purpose of examining engineers as to their fitness for operating steam plants is primarily for safeguarding the public. The only way to do this is to maintain a high standard of operating engineer. When loose methods are permitted by which irresponsible men may obtain a license and stand on an equality with the experienced man in the profession, this standard cannot be maintained.

Mayor Busse has expressed himself as not in a position to do anything in the matter at the present time as there is no appropriation for maintaining a department for the examining of engineers. He does not explain how it came that in the past there had been such an appropriation for this department, nor what becomes of the money which should be used to take care of this work when there are upward of eight thousand engineers in the city, each paying two dollars a year for license renewals.

It is contended by the organized engineers of the city that they should have some representation on the board which controls the issuing of their licenses and that it should once for all be placed on such a satisfactory basis as to be above suspicion and not subject to periodical changes due to disturbances in the city organization. Apparently the engineers are in the right, and they should not cease their efforts until the desired results are obtained.

It seems to be fated that any movement undertaken by engineers primarily for the benefit of the public shall be at the expense of the engineers themselves. Public safety ought to be paid for out of the public funds, the expense being charged to the proper authorities the same as water service and street cleaning from which the public derives benefit; but in the matter of license laws the records show that the engineers as individuals are invariably charged for the expense of this service.

In Chicago money derived from license renewals is more than ample to maintain an organized board of examiners of the highest quality. This money at the present time is being diverted to other purposes and the individual engineer is being charged a fee which ostensibly is used to safeguard the public, but from which, under the conditions, the public derives no benefit.

Compound Engines

"To buy or not to buy" a compound engine is the problem that frequently perplexes the owner or engineer of a power plant.

The advantages of compounding are now so generally understood that one runs the risk of wearying the reader in trying to explain them. A brief recapitulation may not be out of place as an introduction to the subject.

Ordinary saturated steam of about one hundred pounds pressure can be expanded to advantage only four or five times in a single cylinder on account of condensation; that is, the best steam economy will be obtained with a cutoff of one-fourth or one-fifth stroke. Many builders rate their engines accordingly. Noncondensing engines with a single cylinder under these circumstances will use twenty-five or thirty pounds of steam per indicated horsepower per hour. No increase of steam pressure or earlier cutoff will improve the economy materially.

If steam at a higher initial pressure be introduced into a smaller cylinder and expanded before reaching the main or low-pressure cylinder, additional work will be done and a much greater range of expansion be attained without serious condensation.

This seems to be due to the fact that the missing quantity is the steam which is supplied to the cylinder above that which is accounted for by the indicator diagram, and which exists as moisture during the working stroke, is reëvaporated during the exhaust and is available as steam in the next cylinder. The first cylinder must pass on to the next all the heat which it receives and does not convert into work or radiate. If it passed less it would accumulate heat and melt up; if more, it would become a refrigerator. The internal losses become, therefore, those of a single cylinder, and the reduced temperature ranges reduce this loss in either. The reduced pressure difference also reduces the loss by leakage.

Be this as it may, the fact remains that the average compound noncondensing engine has, at full load, a lower water rate than the simple engine.

The compound engine has another advantage in greater uniformity of effort on the crank pin; that is, the sum of the pressures in the two cylinders does not fluctuate as much as would the pressure in a single cylinder.

This is true of either tandem- or cross-compounds and gives better regulation or allows lighter flywheels.

The cross-compound, with cranks at right angles, has the further advantage of a more uniform resultant torque on the shaft and the ability to start from any position, by the use of a bypass valve.

Summing up, we have two advantages from compounding.

Better steam economy.

Better regulation.

To offset these, we have several disadvantages which may be summarized as follows:

Greater first cost.

Larger floor space.

Greater cost of running and repairs.

Roughly speaking, it may be assumed that the cost of a tandem-compound engine will be about fifty per cent. greater than that of a simple engine of the same power and that the cross compound will cost about twice as much as the simple engine. Fourteen or fifteen per cent. of this extra cost will represent the additional annual expense for interest, taxes, depreciation, etc.

The tandem compound occupies slightly more floor space than the simple engine, the cross compound nearly twice as much, and in the event of additional building being necessary, this may be a determining factor.

The greater complexity of the compound engine and its greater liability of suffering from the various complaints to which engines are subjected, are points to be considered.

"Perish the man who makes two connecting rods go, where one went before."

A compound engine requires more care in handling, more careful watching, better lubrication and, in general, a higher grade of superintendence. These disadvantages must be carefully weighed against the advantages for any particular location or set of conditions, before coming to a decision.

One further fact needs to be emphasized—that a compound engine is usually more sensitive to changes of load than a simple one. In order that a compound engine may work with good economy, the total expansion should be correct for the initial pressure used and this expansion should be so divided between the two cylinders as to equalize the work done by the two. In a cross compound, it is further desirable that the total initial pressure on each crank pin should be the same. It is easy to realize these conditions for the rated load of the engine; it is difficult to insure them for varying loads.

A compound engine whose governor regulates the high-pressure cutoff alone is particularly faulty in this respect; when an overload is on, the low-pressure cylinder has to do more than its share of the work and the reverse is true at light loads. Diagrams taken from an engine which is running light frequently show negative work for the low-pressure cylinder. Such an engine does not regulate promptly with sudden changes of load, because the steam admitted at one cutoff has to go through both cylinders before the changed cutoff can have much effect. This type of engine is unsuitable for electrical work such as suburban-railway service; it will be perpetually hunting for equilibrium and never finding it. A throttling governor would give better load distribution but with a fluctuating load might cause tardy regulation.

If governors are used on both cylinders, the load distribution will be much improved but the complication of the engine is increased, particularly if it be of the Corliss type.

If the load factor is high and practically uniform and if the amount of power used justifies the increased expense, a compound engine is a satisfactory investment.

Other things being equal, the machine having the smallest number of parts, the fewest joints and the simplest construction is always the best machine.

It is not the object of this article to discourage improvement but to urge an impartial study of each problem, a summing up of advantages and disadvantages and the striking of a correct balance.

Inquiries of General Interest

Speed and Horsepower of Engine

I have a steam engine with a cylinder 6x12 inches. At what speed shall I run it to get 18 horsepower?

J. J. C.

It will depend on the steam pressure. The horsepower of an engine is the product of the pressure which urges the piston forward and the speed at which it moves. At 100 feet of piston speed per minute with a mean effective pressure of one pound on the piston, the horsepower of the engine will be 0.085, and to get 18 horsepower the work will have to be increased as many times as 0.085 is contained in 18, or 211 times. If the mean effective pressure be increased to 40 pounds the horsepower of the engine will be 3.4 for 100 feet of piston speed, and to get 18 horsepower with a mean effective pressure of 40 pounds the piston speed must be increased as many times as 3.4 is contained in 18, or 5.3. With an engine 6x12 inches, with a mean effective pressure of 40 pounds and a piston speed of 530 feet per minute, 18 horsepower would be developed. Steam pressure and piston speed may be varied, but so long as the product of the mean effective pressure and the piston speed are constant the horsepower will not change.

Negative Loop in Diagram

Please inform me of a method, or methods, of taking the loops out of the indicator diagram. There is also a rattling noise in the cylinder which I should like to get rid of.

C. J. W.

The loop, and probably also the rattling in the cylinder, is due to the fact that the engine is considerably underloaded. The piston creates a partial vacuum in the cylinder when nearing the end of the stroke, and the atmospheric pressure tends to raise the exhaust valve from its seat, which, as soon as steam is admitted, is forced suddenly against the seat. If the lost motion in the valve be slight, a rattling noise will be heard, and, if considerable, the valve will pound. Reversing the pressure on the packing rings while the piston is moving may also tend to produce a rattling noise. These difficulties can be remedied in several ways: By reducing the boiler pressure until the loop disappears; a reducing valve in the main steam pipe will effect the same results; by putting a smaller pulley on the line shaft and reducing the speed of the engine in proportion. The lower speed will require a later cutoff, and that, in turn, will produce a higher terminal pressure and eliminate the loop. The throttle valve may be gradually closed until the steam-chest pressure is reduced by throttling,

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

until the cutoff is lengthened enough to eliminate the loop. And check valves opening inward may be attached to each end of the cylinder, allowing air to enter the cylinder when expansion reduces the pressure below that of the atmosphere.

This last method was patented some fifty years ago.

Riveted Joints and Stays

Please give the method of finding the strength of a riveted joint, and the area of through stays and diagonal stays.

The following formula may be used for estimating the percentage of strength of joints:

$$\text{Per cent.} = \frac{38{,}000 \times A \times N}{60{,}000 \times T \times P} \quad (1)$$

$$\text{Per cent.} = \frac{P - D}{P} \quad (2)$$

in which

A = Area of one rivet in square inches;
N = Number of rows of rivets in the joint;
T = Thickness of plate;
P = Pitch of rivets;
D = Diameter of rivet hole.

The lower value obtained by these rules represents the ratio of the strength of the joint to that of the solid plate. The strength of the joint between any two rivets is,

$$\text{Ultimate strength} = 60{,}000 \times T \times P \times \text{efficiency of joint.}$$

With a factor of safety of 5, the safe stress will be 20 per cent. of the ultimate strength.

Area of through stay is found by the formula:

$$\text{Square inches} = \frac{a \times p}{S \times n}$$

in which

a = Area of head to be stayed;
p = Pressure of steam per square inch;
S = Safe stress per square inch for stays;
n = Number of stays.

Multiply the area of the through stay by the quotient obtained by dividing the actual length of the diagonal stay by the length measured in a horizontal direction; the product will be the area of the diagonal stay.

The maximum stress per square inch net cross-sectional area of stays should be as follows:

Weldless mild-steel head to head or through stays, 8000 pounds.

Weldless mild-steel diagonal or crow-foot stays, 7500 pounds.

Weldless wrought-iron head to head or through stays, 7000 pounds.

Weldless wrought-iron diagonal or crow-foot stays, 6500 pounds.

Welded mild steel or wrought-iron stays, 6000 pounds.

Gain from Heating Feed Water

The exhaust from our two 150-horsepower compound engines goes to a submerged condenser; condensation from the vacuum pump registers 122 degrees. We now take water for boilers from cooler between high- and low-pressure cylinders of air compressor which registers 110 degrees. What would be gained by using condensation from vacuum pump, and would the saving justify installing the necessary apparatus to remove about six quarts of cylinder oil used every twenty-four hours?

R. A. B.

There is a gain of approximately 1 per cent. for each 11 degrees that the feed water is heated before entering the boiler. In your case there would be a difference of 12 degrees, and it would therefore take about 1 per cent. less heat to make your steam if the water of condensation were used instead of the jacket water.

Thickness of Boiler Shell

How would you find out the thickness of the shell in an old boiler?

V. B. D.

If the shell was corroded over large areas the exact thickness could only be determined by drilling. Approximate measurements may be made by making a templet of the same radius as the inner side of the sheet and measuring from it to the bottom of such depression or pits as may exist.

Force, Work and Power

Will you tell me the difference, if there is any, between the meanings of the words force, work and power?

J. L. C.

Force is that which tends to produce motion. Work is the result of the action of force through distance. Power is the rate of work.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

Arctic Horizontal Refrigerating Machine

A new design of refrigerating machine, of the horizontal type, is being built by the Arctic Ice Machine Company, Canton, Ohio, and is illustrated herewith.

The compressor is direct-driven by a Corliss steam engine, as shown in Fig. 1, the steam and compressor cylinders being connected to the same crank shaft. The cranks of the steam and compressor sides are set at an angle of 90 degrees.

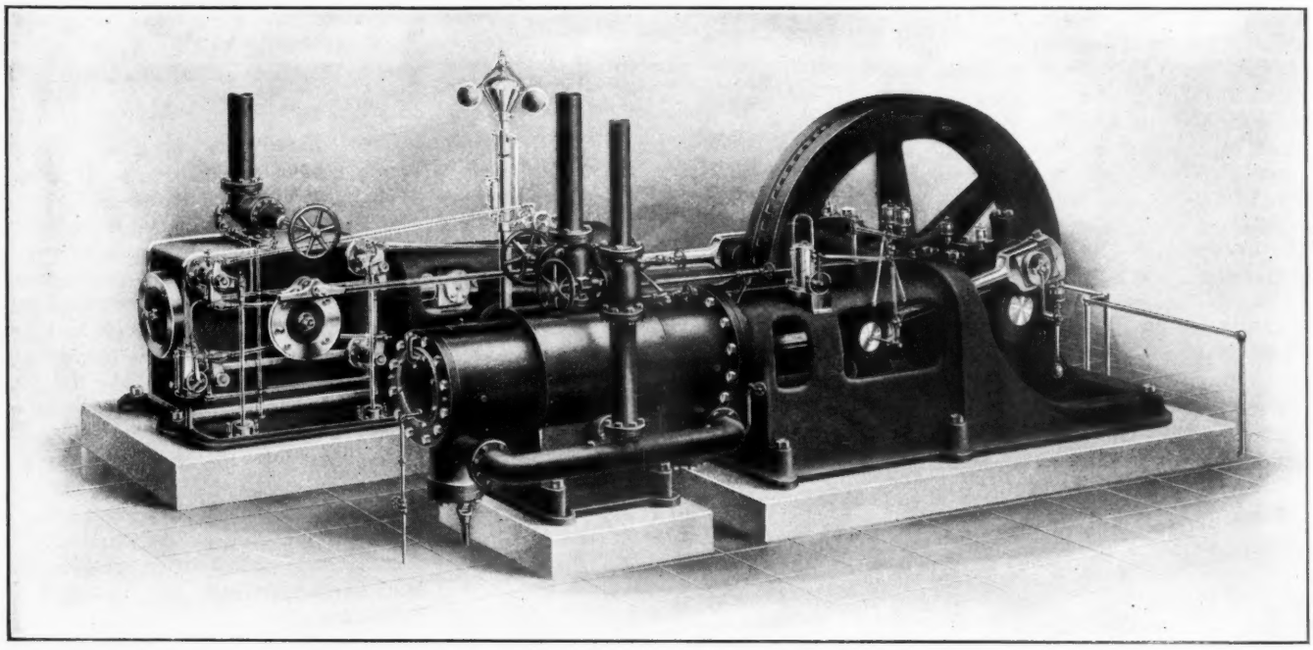


FIG. 1. HORIZONTAL TYPE COMPRESSOR DRIVEN BY CORLISS ENGINE

A peculiar feature of this machine is that the gas first enters an annular space surrounding the compressor cylinder and forming the receiving chamber. This chamber is insulated with molded cork to prevent the absorption of heat from the atmosphere. From the receiving chamber the gas enters the bore of the cylinder through a number of ports, of ample area, and as it comes in contact with cool surfaces, no heat is generated on the suction side of the piston, and the center of the compressor cylinder is kept in contact with cold gas.

The suction valves are placed in the piston, of which there are two, carried on the same rod, as shown in Fig. 2. The effect in each end of the cylinder is that of the single-acting compressor. The movements of the inlet valves are positive, as they are operated by the movement of the pistons which are fitted solidly to the piston rod. The valve seats are formed between the piston head and the sliding shells, which fit the bore of the cylinder and have a fixed amount of travel over the piston heads. The diameter of the valve is large and the movement of the shells is slight.

Opening and closing of the valves is independent of the pressure of gas or the action of springs; therefore, no reduction of the pressure of the incoming gas occurs. Each port is wide open during the entire suction stroke, and at the end of the stroke the compressor has received a full charge of gas at the pressure existing in the suction pipe. The valve is closed at the instant the piston starts on its return stroke, due to the momentum of the shell, which causes it to slide in the direction of travel, until it meets the piston head, thus closing the valve. The movement of the shell on the

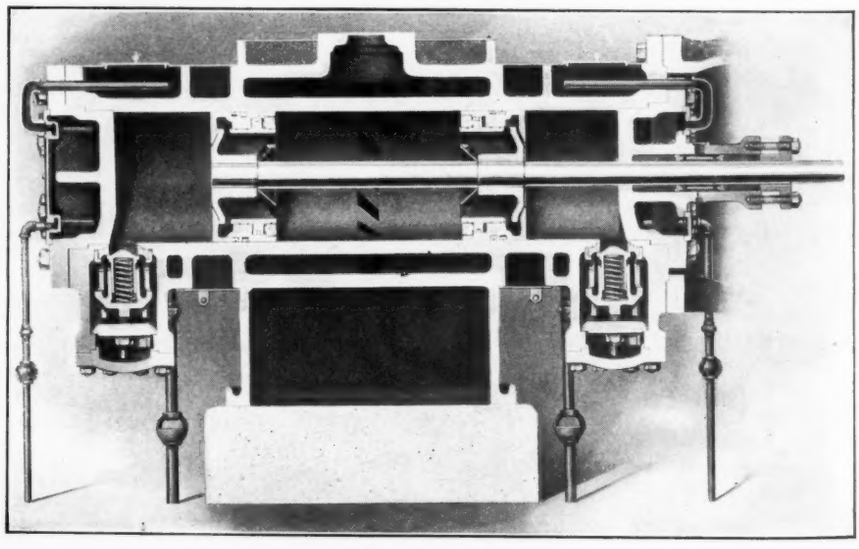


FIG. 2. SECTIONAL VIEW OF THE COMPRESSOR CYLINDER

piston head is cushioned to ease the movement of the valve and to prevent undue noise. Fig. 3 shows the piston and suction valve in detail.

By placing the suction inlet at the center of the cylinder and providing a receiving chamber around the compressor and between the piston, there is practically no danger of getting liquid into the compressor cylinder. Should liquid come over with the suction gas and enter the compressor chamber, it will drain out of the discharge valves when they open, because they are located at the bottom and ends of the cylinder, as shown in Fig. 2. Long coil springs hold the valves against their seats and hasten their closing when the discharge strokes are completed. The seats of both inlet and discharge valves are flat, but in each case there is a lapped surface outside of the seat, which is for the purpose of reducing the clearance.

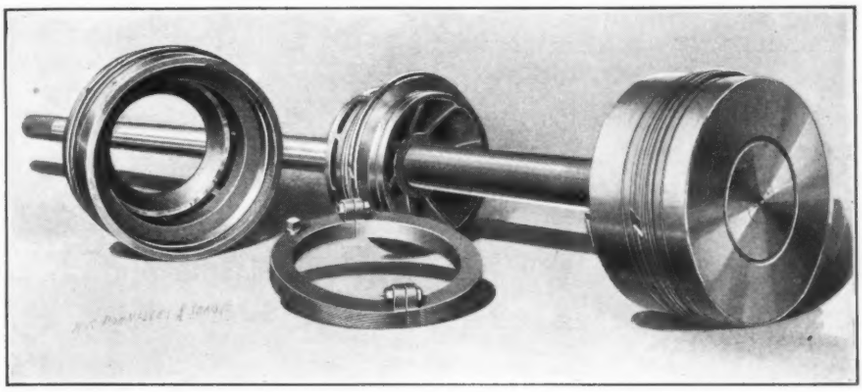


FIG. 3. DETAIL VIEW OF PISTON AND SUCTION VALVE

When the machine is run with wet gas coming from the expansion coils, the evaporation of the liquid that has entered the compressor tends to cool the surface heated by compression at the discharge end of the cylinder, and this eliminates the necessity of a water jacket. When the gas returning to the compressor is superheated, or dry, the heat of compression is very noticeable and the water jacket is then a necessity. When water is used, it is injected against the surface of each cylinder head, as shown in Fig. 4, the large area of the head being used as a cooling surface. The water is carried over the end of the compressor and trickles down the surface to a bowl placed underneath the cylinder around the top of the discharge-valve pot, where the water finally collects to drain to the sewer.

This machine is fitted with bypass piping, consisting of a double connection between the suction and discharge stop valves. These connections are each provided with two valves, one of which is a T-valve fitted with a removable plug. This feature enables the charge of ammonia to be exhausted from either the high- or the low-pressure system and stored in the other. The double valve on each connection permits of pumping an air pressure for testing the system or exhausting the air from either side of the system, independent of the other. The plug openings of the T-valve of the bypass are also utilized as a charging connection, thus making it possible to charge ammonia into the system without pumping a vacuum on the evaporating coils and without interfering with the operation of the plant.

Fig. 5 shows the stuffing box, which is made very deep and is packed with two sections, which are separated by a long oil sleeve. The oil is fed to the sleeve by means of a forced-feed automatic lubricator, through a ball check valve and pipe connected to the side of the stuffing box. The oil discharges from the sleeve through a pipe connecting to the top of the stuffing box and connects with the suction side of the system.

The frame is cast in one piece and is of heavy-duty tangye type.

An open-type crosshead made of cast steel is used. The grooved taper crosshead pin is held in place by a key and a cap with screws.

The main bearing is of the four-part floating type, consisting of two shells and two quarter boxes, the latter being removable while the shaft is in place.

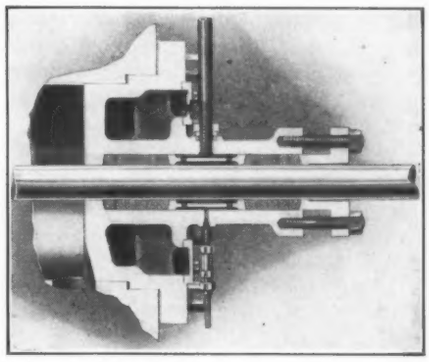


FIG. 5. STUFFING BOX

The horizontal type of machine is built in sizes ranging in capacities from five tons per day upward. Owing to the design of the valve it is possible, if desired, to operate the machine at higher speed than usual, which provides a proportional reserve capacity.

Although the usual arrangement of the machine consists of a left-handed compressor, direct-connected to a right-hand Corliss engine, the machine may be arranged for belt drive, gear or balance-chain drive, or for direct connection to a slide-valve engine, or in the larger sizes, to a gas engine.

The compressor can thus be arranged to suit the equipment installed and the conditions obtaining in any plant.

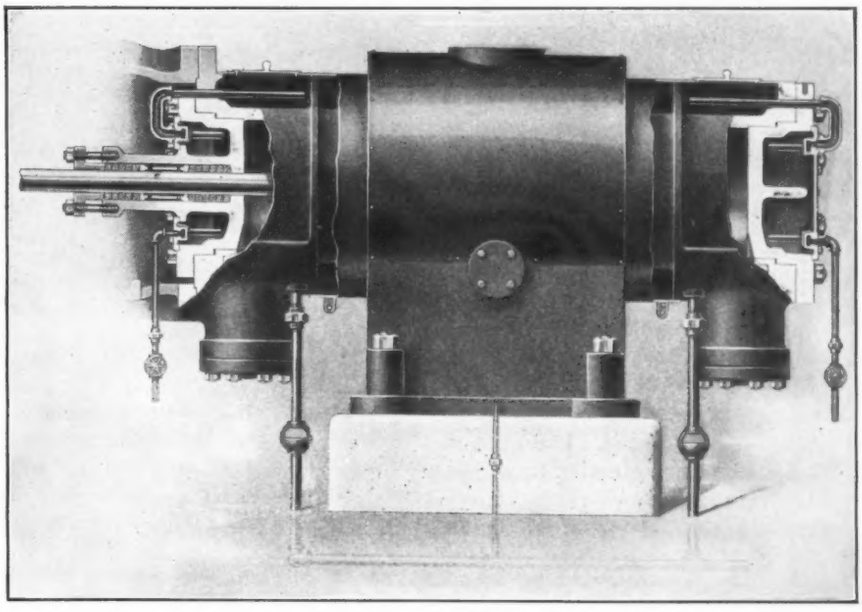
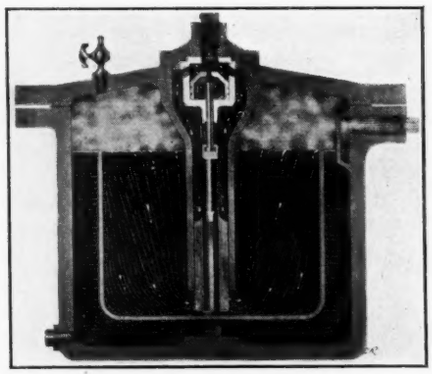


FIG. 4. DESIGN OF WATER-COOLED CYLINDER HEADS

Improvements in the Vance Steam Trap

The Vance steam trap, since it passed into the hands of its present manufacturer, the George M. Newhall Engineering Company, 150 South Fourth street, Philadelphia, Penn., has been considerably widened, while its hight has been somewhat diminished. The cage containing the two valves, as well as the discharge tube, has also been widened, permitting the use of a larger main valve and giving a larger opening for the discharge. This materially increases the efficiency of the trap. The cage has been lengthened to give better support to the auxiliary valve stem, and the winged guides on the stem to which the auxiliary valve is attached have also been widened and better proportioned.



SECTIONAL VIEW OF VANCE TRAP

The auxiliary valve is now made blunt instead of pointed to prevent wiredrawing; it also gives a much more satisfactory opening and fits better to its seat in its present form.

Two relief grooves have been provided on the main valve, which not only prevents sediment from collecting at any point in the travel of the valve, but also makes the valve work easier by acting as a water cushion.

The bonnet is held in position by using four bolts. At the bottom of the trap is placed a raised boss in the center of the shell for the bucket to rest on while discharging, the object being to allow the bucket to drop the full depth while discharging. The new arrangement keeps any part of the bucket from coming in contact with mud, scale or other foreign substances that might collect.

The baffle plate is now made closed at the top and bottom, which causes the water of condensation and steam to break evenly and distribute itself around both sides of the shell without interfering with the bucket.

The blowoff has been changed from its original position, directly under the inlet pipe, to the opposite side of the trap.

New Roto Tube Cleaning Head

The Roto Company, 67 Temple street, Hartford, Conn., has recently placed on the market a new boiler-tube cleaning head for use on its air-driven, steam-driven and water-driven motors.

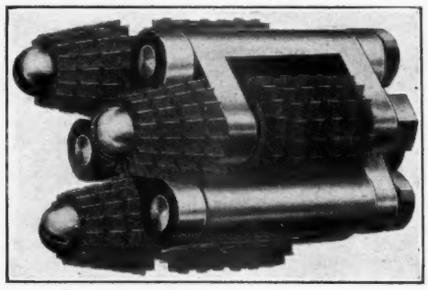


FIG. 1. ROTO SWING HEAD

The head is a multiple cutter of the "centrifugal" type in which the main frame is rigid with the motor shaft and cannot touch the boiler tube, while the cutter frames are forced out independently, by centrifugal action, against the inside of the boiler tube. The general construction is clearly shown by the accompanying illustrations.

Fig. 1 shows the assembled head ready to screw on to the motor. A retaining ring (not shown) carried by the motor shaft, slides over the hub and holds the hinge bolts both from coming out and

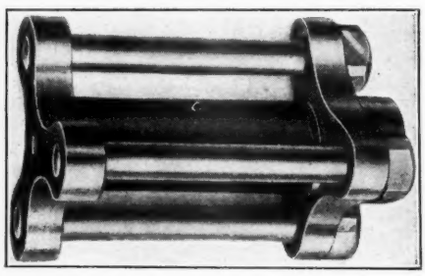


FIG. 2. MAIN FRAME OF HEAD

from turning. While at work, the turning effort of the motor constantly tightens against the retaining ring and holds the head together.

To take the head apart it is only necessary to unscrew it from the motor shaft. The retaining ring, hinge bolts and swing frames then slide out of the spider.

Fig. 2 shows the solid steel spider or main frame with the hinge bolts in place. This spider is made from a solid piece of steel, and is without joints. The central stem is of concave triangular section to admit of using very large cutters up to 1½ inches in diameter on the standard 4-inch head.

A stop is forged on the under side of each swing frame to engage the internal hubs of the spider, and this acts as a stop to limit the outward swing of the frame or prevent it turning clear over when outside the boiler tube.

The construction is entirely rivetless and there are no small pins, trunnions or other parts to break.

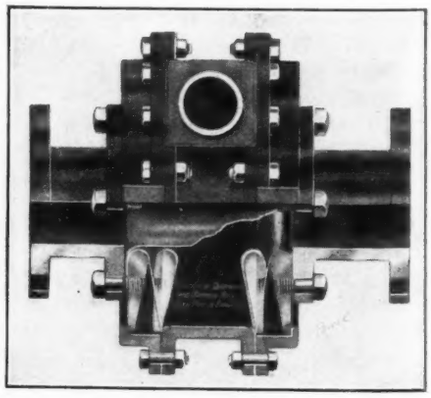
The parallel movement of the cutters to their work insures that all the cutters will work at the same time and each cutter do its full share. The cutters are placed close in front of the sizing end or shield of the motor, and for this reason they cannot pass over the scale. Therefore it is not necessary to pull and push the cleaner back and forth in the boiler tube.

Type "A" Diaphragm Double Expansion Joint

The Central Station Steam Company, Detroit, Mich., has just placed a new type of expansion joint on the market. It is arranged with side anchorage lugs for anchoring in the side walls of the brick or concrete box in which the joint is placed.

Each diaphragm takes care of the expansion in 50 feet of pipe line without increasing the angle through which the copper is bent. One double joint thus provides for expansion in 100 feet of pipe line. Provision is made for 2¼ inches of expansion to each 100 feet of pipe.

An interior view of a complete double joint (without anchor plates) is seen in the accompanying illustration, which shows the position of the diaphragms and backing rings when the pipe is cold. The position of the diaphragm and backing rings is also shown in shadow when the pipe is expanded to its full limit. When in this latter position the copper is drawn against the cast-iron backing ring so that the backing ring forms a reinforcement, and the pressure of the steam is held by the cast-iron ring instead of by



TYPE A DOUBLE-EXPANSION JOINT

the copper. This joint is also made with a single diaphragm for taking up the expansion on one side of the anchor only.

An Engine Wreck

On Friday evening, June 3, an engine breakdown occurred at Birdsboro, Penn., in the power plant of the Birdsboro Steel Foundry and Machine Company. The engine was a horizontal Corliss of recent design and was direct connected to a 300-kilowatt generator. The unit had been in operation for about two years and had given excellent service. At the time of the break the unit was running as smoothly as could be.

As nearly as can be ascertained, the break started with the splitting of the crank disk, and this, of course, started a general smash up; the engine frame incasing the crank disk and connecting rod was broken away well down to the bottom, bending the crank, twisting up minor parts and splintering the end of the main shaft, although it was not bent.

The cause of the break is unknown, but the conclusion can be drawn that it was caused by either one of two things: First, by a rigid examination of the broken crank disk it appears that the disk casting was defective, and, second, although not at all probable, that one of the two keys by which the disk is keyed to the shaft may have worked itself loose and out and caught on the crank, thus causing the splitting of the disk. The first of these causes seems the most plausible.

The engineer escaped with a few scratches and bumps. He was standing near the engine and was knocked down, but at that was the first to close the throttle at the engine.

The firm has another unit of 200 kilowatts in the plant, which will keep the works running till the break can be repaired.

Locomotive Testing Plant Presented to University of Illinois

Upon the recommendation of Robert Quayle, superintendent of motive power and machinery, and with the approval of W. A. Gardner, general manager, the locomotive-testing plant of the Chicago & North Western Railway Company has been presented to the University of Illinois. Under the immediate direction of H. T. Bentley, assistant superintendent of motive power and machinery, it has been taken from its foundation, the bearings and other running parts have been put in good order for service, and the plant with all the special patterns used in its construction has been loaded and shipped to Urbana. It is understood that the plant will be held by the university pending the construction of its proposed transportation laboratory.

The plant consists of foundation plates, pedestals and three pairs of axles with their bearings, supporting wheels, friction brakes, etc. It was the first of its kind to be supplied with permanent mounting rails, by use of which a locomotive could be rolled on or off the wheels without resort to temporary blocking.

It is announced by Dean Goss, of the College of Engineering, that the plant at the university will constitute a portion of the equipment of the School of Railway Engineering and Administration, and that when installed it will be operated under the immediate direction of Prof. Edward C. Schmidt, in charge of railway engineering.

Illinois Gas and Electrical Monopoly

With the granting of a 50-year franchise to the Illinois Valley Gas and Electric Company there has been started a new era in public-service corporations in this State. The plan, of which this is the opening move, involves the chaining up of twenty-six Illinois valley cities and towns for the distribution of gas and electricity from central points. The new company is a subsidiary of the Commonwealth Edison Company, of Chicago, and the Economy Light and Power Company, of Joliet, Samuel Insull being president of all three. The new corporation, it is understood, has been capitalized for $6,250,000 and a bond issue of $10,000,000 has been authorized. The headquarters of the company will be at Streator and the main gas-producing plant will also be located there. Among the cities included in the circuit in addition to Streator will be Ottawa, Marseilles, Morris, Dwight, Coal City, Braidwood and Wilmington. To complete the consolidation the new company absorbed eleven gas and electric plants, the last being the property of the Illinois Light and Traction Company. According to plans given out it is understood that electrical current will be distributed from the Economy Company's water-power plants at Joliet and Wilmington, and a 10,000-horsepower auxiliary steam station will be located at one of these points, additional steam stations being constructed wherever necessary to insure high-class service.

Steamboat Inspection Service

How many know just what is the scope and purpose of the steamboat-inspection service, and the aid it desires to render to the marine interests of the country? Those interested can procure copies of the following-named publications upon application to the Supervising Inspector-General, Steamboat-Inspection Service, Department of Commerce and Labor, Washington, D. C.: General Rules and Regulations Prescribed by the Board of Supervising Inspectors; List of Licensed Officers of Merchant, Steam, Motor and Sail Vessels; Laws Governing the Steamboat-Inspection Service; Pilot Rules for the Great Lakes and their Connecting and Tributary Waters; Pilot Rules for the Rivers whose Waters Flow into the Gulf of Mexico and the Red River of the North; Pilot Rules for the Inland Waters of the Atlantic and Pacific Coasts, and the Gulf of Mexico; Annual Report of the Supervising Inspector-General, Steamboat-Inspection Service.

Heating Engineers Meet in Toledo

On June 1, 2 and 3 the National District Heating Association held its second annual convention in the Boody house, Toledo, O. President Rogers presided and during the three days' session a number of interesting papers were presented. Abstracts of some of these papers appear elsewhere in this number and some of the papers will be presented in a later number. The following officers were elected: President, George W. Wright, Baltimore; first vice-president, A. D. Spencer, Detroit; second vice-president, W. J. Gramps, Seattle; third vice-president, Warren Partridge, Springfield; secretary-treasurer, D. L. Gaskill, Greenville; members executive committee, A. C. Rogers, Toledo, and E. J. Keifer, Easton, Penn. Next year the convention will be held in the East, the place and date to be decided on later.

SOCIETY NOTES

On account of further time desired by exhibitors and in deference to the wishes of prominent speakers who were unable to attend on original date, the convention of the International Congress of Inventors has been postponed from June 13-18 to October, the exact date to be announced later.

The twentieth anniversary of Robert Fulton National Association of Stationary Engineers Association No. 28, of Chicago, was celebrated on the evening of Thursday, June 9, by a dinner at the Chicago Automobile Club. Two hundred and forty-one members and friends of the association were present at the happy event, which gives an indication of the strong hold No. 28 has upon the engineers of Chicago. After a prayer by Brother Leander Haynes and a song by the Ingleside quartet, President Frank P. Elliott introduced as toastmaster of the evening, John F. McGrath, and under his successful ministrations there followed an interesting program of speaking interspersed with songs by the Ingleside quartet. The program included "Twenty Years Ago," by James G. Beckerleg; "The Press," by John W. Lane; "The N. A. S. E.," by F. W. Raven; "Engineers," by Clare F. Wilson. Paul P. Bird, city smoke in-

spector, and A. L. Abbott, of the Commonwealth Edison Company, both congratulated No. 28 on the progress it had made and the high standing of its members in the engineering profession.

PERSONAL

George B. Foster has been appointed Chicago sales manager for the Wisconsin Engine Company, Corliss, Wis. His offices will be located in the Fisher building.

L. A. Gordon, formerly with the construction department of the American Optical Company, Southbridge, Mass., has resigned to carry on a general engineering business.

Lucuis I. Wightman, for the past six years advertising manager for the Ingersoll-Rand Company, New York, has resigned his position, the resignation taking effect August 1. He will open an office in New York City as an independent specialist in machinery advertising, handling the accounts of manufacturers of machinery and engineering products.

NEW INVENTIONS

Printed copies of patents are frnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

WATER MOTOR. Henry T. Farnsworth, Altavista, Va. 959,491.

FLUID OPERATED APPARATUS. Eugen Ketterer, Essen-on-the-Ruhr, Germany. 959,547.

EXPLOSION OR COMBUSTION MOTOR OR PUMP. Carl Alrik Hult and Oscar Walfrid Hult, Stockholm, Sweden. 959,748.

INTERNAL COMBUSTION ENGINE. Laurits T. Rasmussen, Council Bluffs, Iowa, assignor to Walker Manufacturing Company, Council Bluffs, Iowa, a Corporation of South Dakota. 959,805.

ROTARY ENGINE. Frank Joseph Sproehnle, Philadelphia, Penn. 959,812.

ROTARY ENGINE. George Hurlstone Hardy, Twickenham, England. 959,856.

EXPLOSIVE ENGINE. Jay E. Woolf, Minneapolis, Minn., assignor of one-half to Ellis J. Woolf, Minneapolis, Minn. 959,905.

COMBUSTION TURBINE. Sebastian Ziani de Ferranti, Hampstead, London, England. 960,160.

BOILERS, FURNACES AND GAS PRODUCERS

GRATE. William E. Marengo, Worcester, Mass., assignor of one-half to John B. Proulx, Southbridge, Mass. 959,568.

WATER-TUBE STEAM GENERATOR. James H. Rosenthal and Arthur Spyer, London, England, assignors to the Babcock & Wilcox Company, Bayonne, N. J., a Corporation of New Jersey. 959,612.

FURNACE. Jacob Weintz, Cleveland, Ohio, assignor to the Strong, Carlisle & Hammond Company, Cleveland, Ohio, a Corporation of Ohio. 959,980.

BOILER HEADER. William F. Sellers, Wilmington, Del. 960,044.

BOILER ATTACHMENT. Gideon M. Morris and John H. Watkins, Palestine, Texas, assignors of three-twelfths to J. O. Roberson, three-twelfths to W. R. Collier, one-twelfth to Nat M. Crawford, Grand Saline, Tex., and one-twelfth to W. B. Wynee, Wills Point, Tex. 960,229.

POWER PLANT AUXILIARIES AND APPLIANCES

INDICATOR REDUCING-MOTION MECHANISM. Frederick O. Ball, Plainfield, N. J. 959,443.

DOUBLY ACTUATED EXPANSION VALVE. George P. Carroll, Bridgeport, Conn. 959,458.

GOVERNOR FOR STEAM OR ELASTIC FLUID ENGINES. Charles W. Dake, Grand Rapids, Mich., assignor to the Dake-American Steam Turbine Company, Grand Rapids, Mich. 959,471.

PRESSURE REGULATOR. George C. Davis and Walter A. Daley, Chicago, Ill., assignors to George M. Davis Regulator Company, Chicago, Ill., a Corporation of Illinois. 959,474.

CHARGING DEVICE FOR CALORIMETER BOMBS. Charles J. Emerson, Providence, R. I. 959,488.

PUMP. John Holst, Berkeley, Cal. 959,533.

STEAM TRAP. George E. Hulse, Jersey City, N. J., assignor to the Safety Car Heating and Lighting Company, a Corporation of New Jersey. 959,541.

TOOL FOR CLEANING TUBES. Charles F. Overly, Pittsburg, Penn., assignor, by mesne assignments to Enterprise Machine Manufacturing Company, a Corporation of Pennsylvania. 959,585.

STEAM TRAP. Charles E. Squires, Cleveland, Ohio. 959,636.

CONDENSER. Alfred Steinbart, Pittsburg, Penn. 959,640.

OIL CUP. William E. S. Strong, Chicago, Ill., and Frank V. Bartlett, Detroit, Mich., assignors to the Winkley Company, Detroit, Mich., a Corporation of Michigan. 959,643.

VALVE SEAT GRINDER. Elvin E. Townsend, Oakland, Cal. 959,653.

TRAP REST. John W. Walter, Canton, Ohio. 959,659.

ENGINE VALVE. Arthur J. Anderson and George A. Hanson, Aberdeen, S. D. 959,689.

DRAW-OFF COCK FOR BOILERS. William L. Belknap, Bridgeport, Conn. 959,698.

PIPE UNION. Frederick C. Blanchard and Ernest B. Crocker, Bridgeport, Conn., assignors to the Ashcroft Manufacturing Company, Bridgeport, Conn., a Corporation of Connecticut. 959,702.

STOP VALVE AND THE LIKE. Joseph Fletcher, Stoke Newington, England, assignor to Clark Way Harrison, London, England. 959,728.

MUFFLER. William J. Hewitt, San Francisco, Cal., assignor to Frank B. Keever, San Francisco, Cal. 959,742.

VALVE-OPERATING MECHANISM. John T. Knott, Fort Wayne, Ind., assignor to Knott Van Arnam Manufacturing Company, a Corporation of Indiana. 959,758.

VALVE. Samuel E. McKnight, Lohn, Texas. 959,784.

TRIPLE VALVE. William A. Pendry, Detroit, Mich. 959,800.

ATTACHMENT FOR STEAM TRAPS. Richard J. Flinn, Boston, Mass. 959,927.

METHOD OF OPERATING EXPLOSIVE ENGINES. Prosper L'Orange, Mannheim, Germany. 959,951.

PIPE COUPLING. Olaf E. Oleson, Chicago, Ill. 959,960.

ENGINE-STARTING DEVICE. Harry C. Colhower and James T. Sainsbury, Hartford City, Ind. 959,997.

OIL CAN. William V. Evans and Henry C. Gordon, San Diego, Cal. 960,008.

MEANS FOR FEEDING FLUID OIL. Thomas Turnbull, Jr., Pittsburg, Penn. 960,057.

CARBURETER. Thomas J. Fay, New York, N. Y., and John Magee Ellsworth, Bernardsville, N. J. 960,080.

AUXILIARY AIR VALVE FOR CHARGE-FORMING DEVICES. Jacob H. Friedenwald, Baltimore, Md. 960,084.

OIL CUP. Joseph N. Hawkins, Manningtion, W. Va. 960,172.

GOVERNING MECHANISM FOR EXPLOSIVE ENGINES. Garfield H. Hayes, Franklin, Penn., assignor to Sterling Oil Engine Company, Pittsburg, Penn., a Corporation. 960,173.

PIPE CONNECTION. Fred L. Sehnert and George J. McManus, Houston, Tex., assignors of ninety-five one-hundredths to said McManus and five one-hundredths to said Sehnert. 960,204.

FEED-WATER HEATER. Jared S. Sweeny, and William W. Grindle, Decatur, Ill. 960,209.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRICAL-MEASURING INSTRUMENT. Charles Edwin Foster, Rochester, N. Y. 959,497.

ELECTRIC DRIVING DEVICE FOR REGISTERING MACHINES. Charles F. Kettering, Dayton, Ohio, assignor, by mesne assignments to the National Cash Register Company, Dayton, Ohio, a Corporation of Ohio. (Incorporated in 1906). 959,548.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., W. W. Freeman, Brooklyn, N. Y.; sec., T. C. Martin, 33 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City. Next semi-annual meeting, St. Louis, Mo., June 30 and July 1, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.